FREE: 16-page Equipment Directory

ASTRONOMY

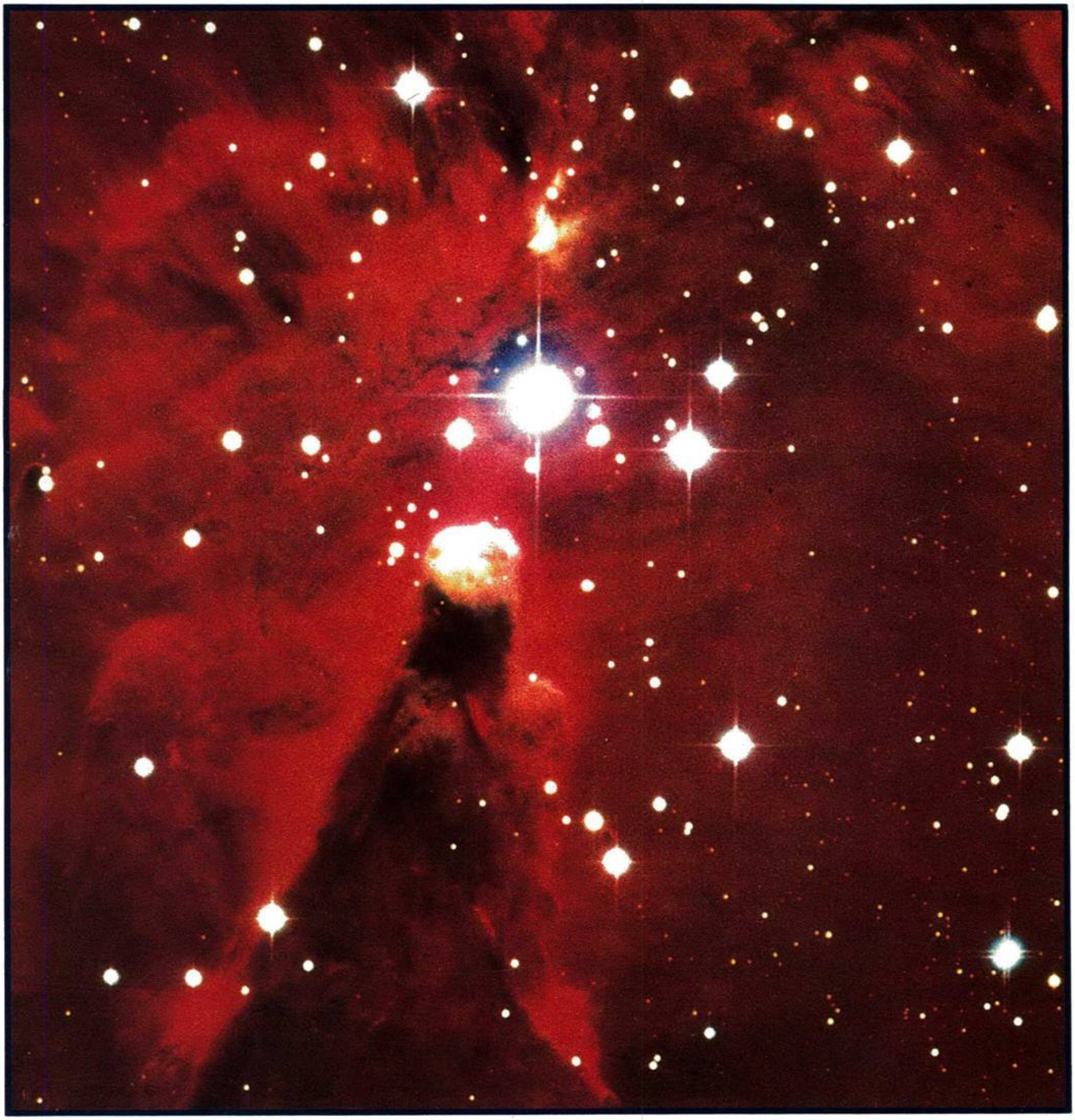
October 1987
U.S. $2.50
UK £1.15
Can. $2.95

Space, Time, and the Universe

Are Refractors Really Better?

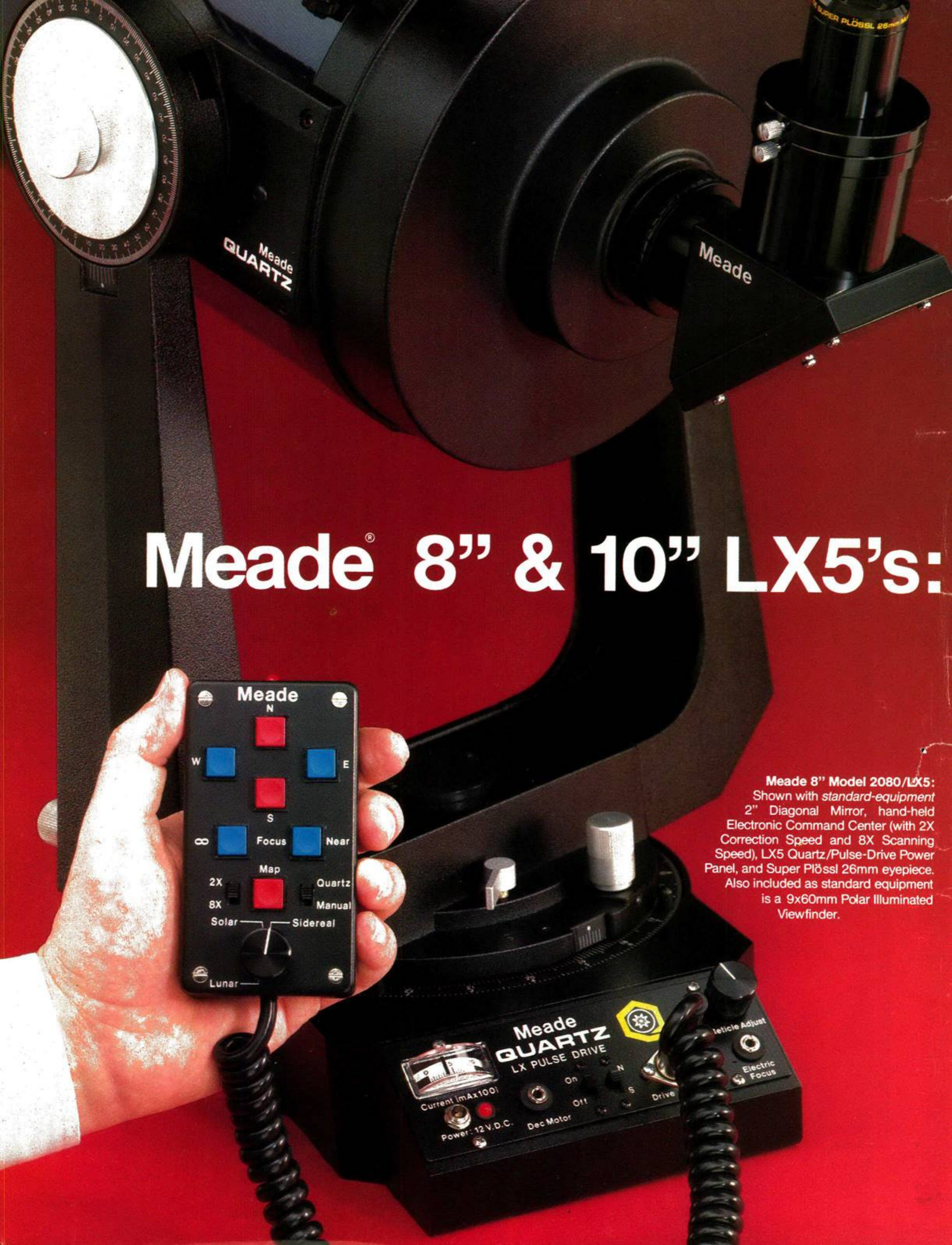
Recreating the First Moon Photo

ICD# 08070



The Cone Nebula in Monoceros

0 08070 10
771855


SUPER PLÖSSL 26mm
Meade QUARTZ
Meade
Meade
N
W
E
S
∞ Focus Near
Map
2X
8X
Quartz
Manual
Solar
Sidereal
Lunar
Meade QUARTZ LX PULSE DRIVE
Current (mAx100)
Power: 12 V.D.C.
Dec Motor
On
Off
N
S
Drive
Reticle Adjust
Electric Focus

Meade® 8" & 10" LX5's:

Meade 8" Model 2080/LX5: Shown with *standard-equipment* 2" Diagonal Mirror, hand-held Electronic Command Center (with 2X Correction Speed and 8X Scanning Speed), LX5 Quartz/Pulse-Drive Power Panel, and Super Plössl 26mm eyepiece. Also included as standard equipment is a 9x60mm Polar Illuminated Viewfinder.

Scan the Moon at the Touch of a Button!

New! Meade LX5's Include Advanced High-Speed Scanning Electronics.

And the Most Impressive Listing of *Standard Equipment* on *Any* Commercial Telescopes:

1 Electronic Command Center: This *standard* feature puts virtually all telescope functions at your fingertips! Flip to the 8X Scanning Speed, and you're roving over the lunar surface at high speed, or touring the Orion Nebula, all at the touch of a button. Add the optional Declination motor for full dual-axis capability and you'll probably never use manual RA and Dec controls again! Use the 2X Correction Speed for micro-guiding corrections during astrophotography.

The Ultimate SC's.

2 Power Panel Display: Monitor telescope operations at a glance. Panel modules include **(a) Ammeter**—Continuously displays electric current usage, to gauge battery life during power cell operation; **(b) North-South Switch**—Use your LX5 anywhere in the World! Simply flip the N-S switch to reverse drive direction for operation in the Southern hemisphere; **(c) 12-Volts DC Power Inlet**—Each LX5 includes power cords for *3 types* of field operation: Directly from auto cigarette lighter plugs; directly from 115 v.AC house outlets; and from the Battery Pack, included, using AA-size batteries supplied by the user.

In addition, display panel output jacks are provided for the following optional systems: **Declination Motor,** for 2X/8X dual-axis operation; **#1200 Electric Focuser,** for ultraprecise microfocusing; and the **12mm Illuminated Reticle Eyepiece,** for guiding during astrophotography.

3 New Quartz/Pulse Electronic Drive System: The most precise drive system available on any commercial telescope. Quartz microcircuitry drives the RA pulse motor and LX worm gear system to achieve true sidereal-rate tracking within ±.005% of the sidereal frequency. Or, switch to the "Manual" mode for variable Solar, Lunar, or Planetary tracking rates.

Meade 8" Model 2080LX5: Shown with *standard-equipment* 9x60mm Polar Illuminated Viewfinder, 2" Diagonal Mirror, Equatorial Wedge, Field Tripod.

4 2" Diagonal Mirror: Yes, a multi-coated 1/10-wave-flat Diagonal Mirror, accepting both 1¼" and 2" eyepieces, as *standard equipment!* Purchased separately, the 2" Diagonal is normally a $300 optional accessory.

5 9x60mm Polar Illuminated Viewfinder: A super-large-aperture finder for easy location of faint objects; yields 44% brighter images than standard 50mm finders. Includes etched reticle scale for extremely accurate polar alignment.

6 Multi-Coated Optics Group: Standard on all 8" and 10" LX5's, the Multi-Coated Optics Group includes multi-layer coatings on the primary and secondary mirrors, as well as both sides of the correcting plate, for maximum light transmission and image brightness.

7 Super Plössl 26mm Eyepiece (1¼" OD): Exquisite definition, resolution, and color correction from edge-to-edge of the visual field.

Plus all of the performance and features you expect from a Meade Schmidt-Cassegrain:

☐ *Certified, laser-tested, diffraction-limited optics*—the finest available from any manufacturer.

☐ *Equatorial Wedge,* with magnetic compass, latitude scale, bubble level, and micrometric azimuth control.

☐ *Fully adjustable Field Tripod*—the most stable in the industry.

☐ *Lifetime Warranty*—for long-term protection of your investment. See the Meade catalog for full details.

Meade 8" Model 2080/LX5 and 10" Model 2120/LX5 are available *now* from your Meade dealer—at very competitive prices!

See for yourself why these are the ultimate instruments for *your* observing program—from the World's leading manufacturer of Schmidt-Cassegrain telescopes.

Meade Series 4000: Now *Number One* Worldwide!

Meade Series 4000 oculars, the World's largest-selling premium-grade eyepieces, are now available at super savings from participating Meade dealers! The Series 4000 eyepieces are unequalled in image sharpness and resolution. Try one in your telescope—whether Schmidt-Cassegrain, reflector, or refractor—and see what *you've* been missing!

U.S. and Canada Dealer Locations and Assistance

There are more than 800 Meade dealer locations in the U.S. and Canada. For the one nearest you, or for free telescope information and assistance, call Meade Instruments **toll-free** from anywhere in the continental U.S.A. (except Calif.):

1-800-854-7485

From all other areas, including California, call direct: **(714) 556-2291**

Complete Meade General Catalog - $3.00

Send $3.00 for your copy of the Meade full-color **General Catalog #87C.** We'll also include a copy of the Meade 36-page **Accessories Catalog and Observer's Guide**. Meade General Catalogs are forwarded by First Class Mail.

Meade Instruments Corporation
1675 Toronto Way, Costa Mesa, Calif. 92626 ☐ (714) 556-2291

© 1987

ASTRONOMY

Vol. 15, No. 10
October 1987

The World's Most Beautiful Astronomy Magazine

Editor-in-Chief
Richard Berry
Managing Editor
Stephen Cole
Art Director
Thomas L. Hunt
Assistant Editors
David J. Eicher
Jeff Kanipe
Kristine R. Majdacic
Richard Talcott
Contributing Editor
Robert Burnham
Assistant Art Director
Todd Graveline
Typesetter
Jennifer J. Devlin
Editorial Assistant
Amy Offner

Publisher
Robert A. Maas
Advertising Sales Manager
Dana-Lynne Terry
Product Manager
Susan Poole
Circulation Director
Gary Dolzall

Advertising Dept.
(800) 558-1544
Adv. Rep. — NE Region
Adpress, Inc.
New York, NY 10016
(212) 679-1710
U.S. Newsstand Distribution
I.C.D., The Hearst Corp.
New York, NY 10019
Canadian Newsstand Dist.
Telemedia Dist.
Toronto, Ontario M4S 3B3
World Newsstand Distribution
Boarts International, Inc.
New York, NY 10019

6 **The Geometry of Space and Time**
by James Charles LoPresto

20 **Earth and Moon Together**
by Hank Brandli

Forum 24 **Astronomy 101: Alone against the Universe**
Rising above the World
Breaking 'Aperture Fever'
Seeing a Vampire in the Mirror
The Golden Age of Science Is Now

In Focus 32

Behind the Scenes 33

Astronomy Reviews 38

Special Section 46 **ASTRONOMY's 1987 Guide to Telescopes**

48 **Do Your Homework before You Buy**
by Bill Volkart

66 **The Refractor Advantage: Quality over Size**
by Alan Dyer

74 **1987 Telescope Buyer's Guide**
by the staff of ASTRONOMY

Eye on the Sky 54 **Jupiter at Best Visibility**
by Robert Burnham

AstroNews 86

AstroCalendar 92

Stellar Frontiers 98 **The Moon on a Silver Plate**
by Jan K. Herman and M. Susan Barger

AstroMart 105 **ASTRONOMY Advertiser Index**

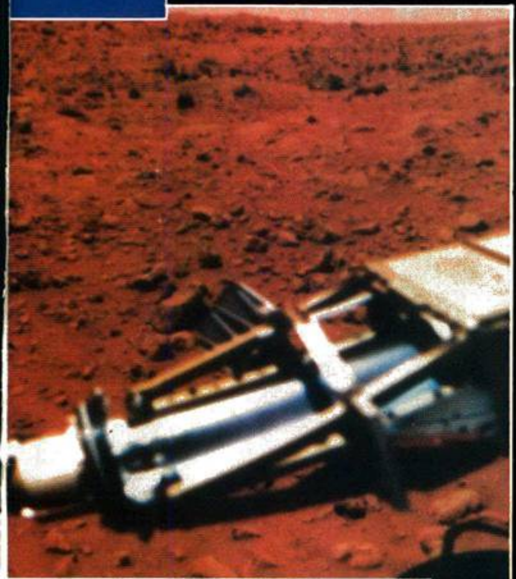
The Backyard Astronomer 110 **Aries**

Cover: The velocities, forces, and scales of time and distance we find in the universe outstrip Newtonian mechanics. We need a more powerful physics to understand the stars and the places where they form and die. Photo of the Cone Nebula copyright 1981 Anglo-Australian Telescope Board. These pages: An evening of stargazing often begins with a look at the setting crescent Moon. Photo by Jim Baumgardt.

ASTRONOMY (ISSN 0091-6358) is published monthly by AstroMedia, a division of Kalmbach Publishing Co., 1027 N. Seventh St., Milwaukee, WI 53233. Copyright © 1987 Kalmbach Publishing Co., all rights reserved. Material in this publication may not be reproduced in any form without permission. Second class postage paid at Milwaukee, WI and additional mailing offices. POSTMASTER: Send address changes to ASTRONOMY, 1027 N. Seventh St., Milwaukee, WI 53233. Questions about subscriptions and product orders: (414) 272-2060 weekdays, 8:30am - 4:45pm. Allow six to eight weeks for new subscriptions and changes of address. New subscriptions start with current issue. Subscription price: 1 year, $21.00. All foreign: add $5.00 per year; please remit in U.S. funds. Send editorial and business inquiries and submissions to the address above. Telephone: (414) 272-2060. Not responsible for unsolicited materials. ASTRONOMY is indexed in *The Reader's Guide to Periodical Literature*. Microfilms of ASTRONOMY available from University Microfilms, Inc., 300 N. Zeeb Rd., Ann Arbor, MI 48106. Printed in the U.S.A.

The Geometry of SPACE and TIME

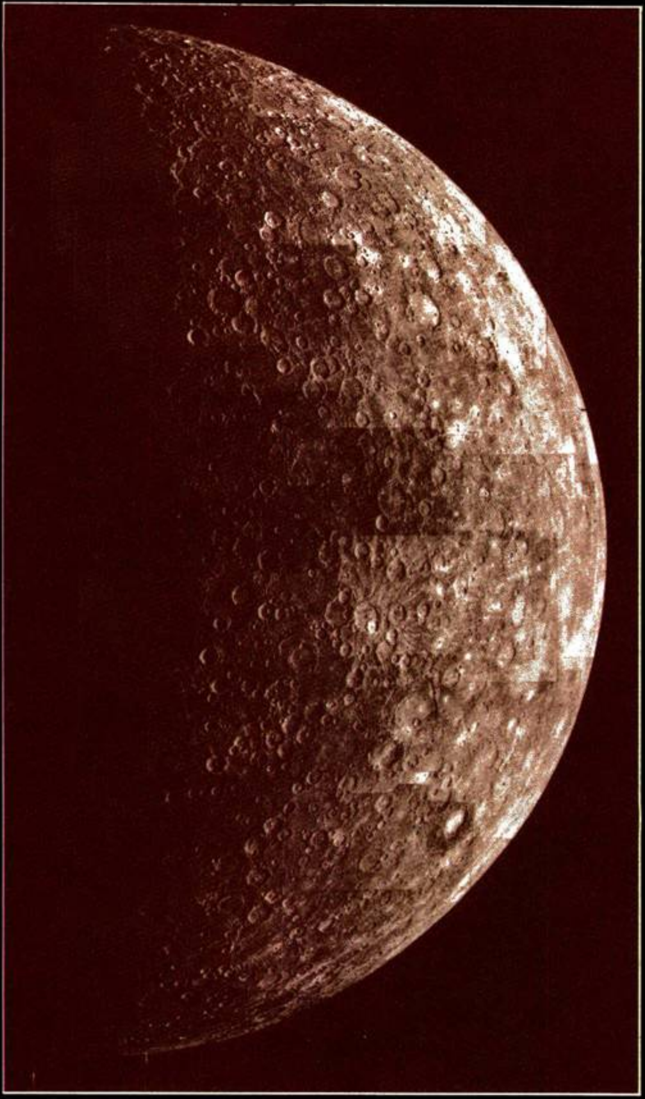
by James Charles LoPresto



Mercury revolves around the Sun, its orbit changing more rapidly than the gravitational pull of the other planets can explain. One of the *Viking* spacecraft sends a radio message to Earth, which arrives a tiny fraction of a second later than it would have if the signal traveled in a "straight" line. Light from a remote quasar passes a large, previously unseen galaxy, and astronomers on Earth see two identical images of the quasar. Two stars in a binary system slowly spiral toward each other as they lose energy in a mysterious way.

What do these seemingly disparate events have in common? All are direct consequences of Einstein's gen-

The Shifting Orbits of Mercury and PSR 1913+16



Mercury as seen by Mariner 10. NASA/JPL photo.

Each time Mercury reaches its closest point to the Sun, the orientation of the planet's orbit has shifted forward by a small angle. By far the largest fraction of this shift comes from the gravitational pull of the other planets, but there is still a tiny, residual effect left over after this is taken into account. Not until Einstein developed his general theory of relativity could the excess be explained.

Mercury's perihelion shift — the shift in the planet's position at its closest approach to the Sun — was the only prediction of general relativity that could be immediately tested. Under Newton's laws Mercury's perihelion should advance by about 531 arcseconds per century because of the gravitational effects of the other planets. But the observed perihelion shift is some 43 arcseconds per century greater than that value.

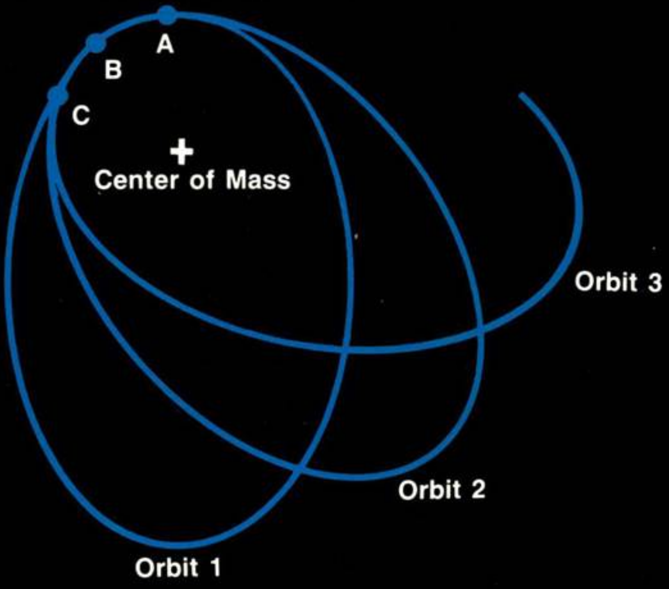
Astronomers in the nineteenth century tried to explain this excess in many ways. The most appealing proposal was made in 1845 by French astronomer Urbain Leverrier, who believed that an undiscovered planet located between Mercury and the Sun could perturb the orbit of Mercury just the right amount. (Leverrier would go on to greater fame the following year when he correctly calculated the position of Neptune from discrepancies in the orbit of Uranus.) Searches for the planet turned up empty, however, despite a few reported sightings.

General relativity predicts a perihelion shift for Mercury of 43.03 arcseconds per century. Measurements over the past three centuries have confirmed this value to within 1 percent.

The perihelion shift of any object in the solar system depends on the mass of the Sun, the distance of the object from the Sun, and the eccentricity of the object's orbit. The shift is greatest for objects close to the Sun with large eccentricities. Perihelion shifts for Venus, Earth, and the asteroid Icarus can also be measured, but these shifts are substantially smaller than Mercury's and much harder to observe.

The effects of general relativity in the solar system are small compared to effects elsewhere in the universe, simply because conditions in the solar system are less extreme. The binary pulsar PSR 1913+16 (see "The Quest for Gravity Waves" on page 18) is a case in point. The two stars in this binary system follow highly eccentric orbits, revolve in a period of just 7 hours and 45 minutes, and are very close to each other. This produces a very large shift in periastron — the point of closest approach for the two stars — of some 4.2 *degrees per year*. Although some of this shift may be caused by nonrelativistic effects, it shows how the same physical laws that cause large effects in the most extreme stellar oddballs also affect our own solar system.

The orientation of the binary pulsar's orbit shifts forward by a whopping 4.2 degrees each year (the effect is exaggerated in the diagram). This advance of periastron — from point A to B to C — is due to the same general relativistic effect that induces Mercury's perihelion to shift forward by 43 arcseconds each century.



The Geometry of Flat and Curved Spaces

Visualizing the four-dimensional geometry of space-time is virtually impossible, but the concepts are easier to understand by analogy to three-dimensional space. Flat space, the domain of Euclidean geometry, is depicted in Diagram 1. Here the sum of all angles in a triangle equals 180° and the area of a circle is πr^2. On the curved surface of a sphere (Diagram 2) the angles in a triangle add up to more than 180° and circles have areas less than πr^2. On a saddlelike surface (Diagram 3) the sum of the angles in a triangle is less than 180° and circles have areas greater than πr^2.

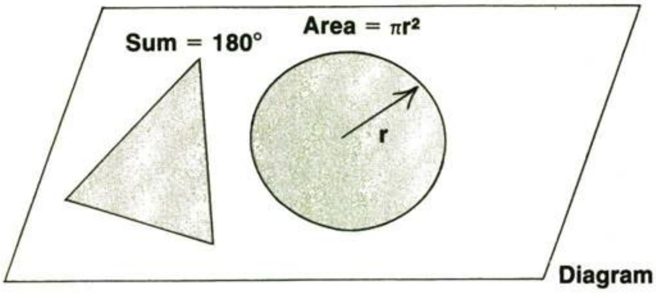


Diagram 1

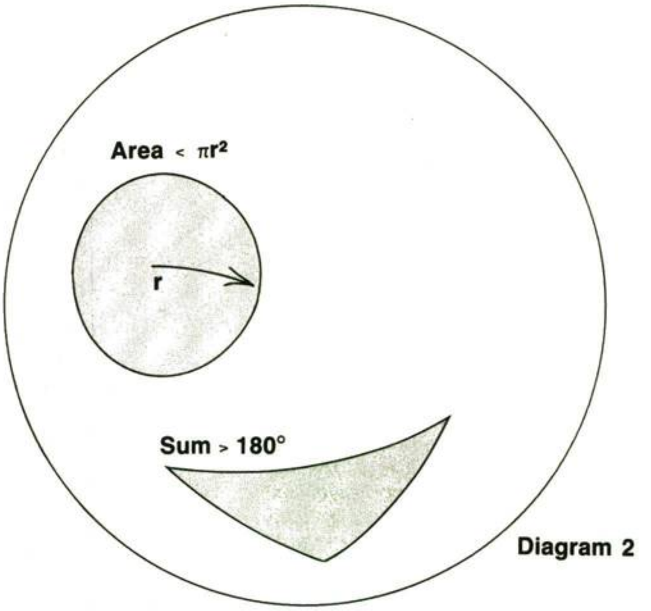


Diagram 2

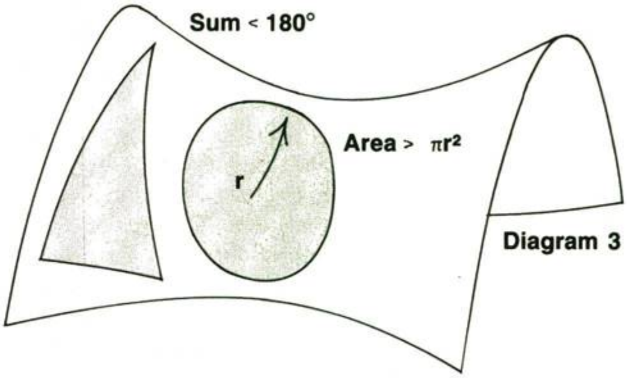


Diagram 3

eral theory of relativity. Far from an esoteric theory at the fringes of advanced physics, general relativity plays a central role in many areas of astronomy and astrophysics. From the confines of our solar system to the outermost regions of space, general relativity is a powerful tool in our quest to understand the universe.

The Central Idea

> *"I have not been able to discover the cause of those properties of gravity from phenomena, and I frame no hypotheses; . . . to us it is enough that gravity really does exist, and act according to the laws which we have explained, and abundantly serves to account for all the motions of the celestial bodies, and of our sea." — Sir Isaac Newton*

When Albert Einstein published his general theory of relativity in 1916, Isaac Newton's theory of universal gravitation was already some two and a half centuries old. Based largely on astronomical phenomena, Newton's theory was a triumphant success — it not only explained motion caused by gravity on Earth but also in the solar system and out to the stars. However, many physicists were troubled because gravity had no apparent cause in Newton's system. General relativity showed that instead of a force, as Newton envisioned, gravity is actually a natural consequence of the geometry of the universe.

The main assumption in Einstein's theory is that the universe consists of a four-dimensional (4-D) space-time. This 4-D space-time is composed of three space dimensions — what we call length, width, and height — and one time dimension, which goes from the past through the present to the future. In Newton's view space and time were totally separate entities that existed without reference to anything external.

Just as space consists of an infinite number of points, space-time consists of "events." An event is some type of happening at a specific point in three-dimensional space and at a precise instant in time. It is not enough to say where a particular event occurs: the time at which it occurs is equally important.

The central idea of the general theory of relativity is revealed in Einstein's field equations. These equations essentially state that matter and energy curve or warp the geometry of space-time. It is this curvature that manifests itself as gravity.

Special and General Relativity

In the absence of mass or energy, space-time is flat, and there is no gravity. More importantly, when viewed on a small enough scale (locally, as the physicists say), curved space-time behaves as if it is flat. This is the same effect that governs our perception of Earth's surface: when viewed from space the surface of our planet is obviously curved, but on a small scale it appears flat.

In flat space-time the laws of physics are described by Einstein's special theory of relativity. Here every particle moves in a straight line at a constant velocity. Only when you look beyond the local area does space-time appear curved, and only on these scales are the effects of gravity noticeable.

Space versus Space-Time

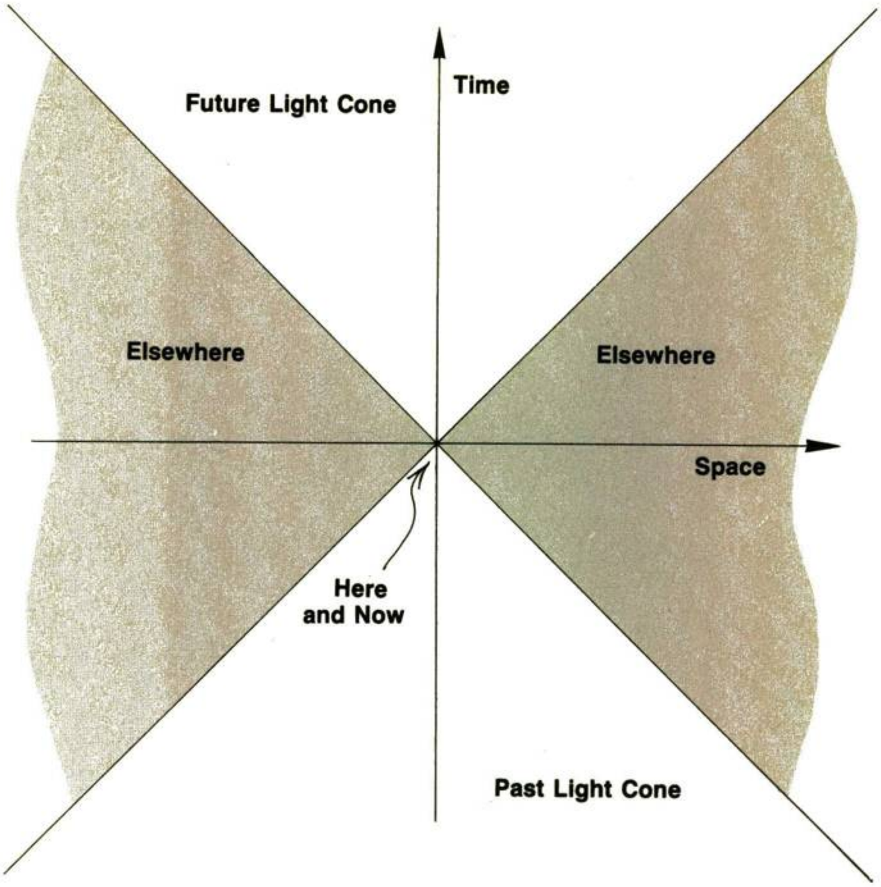
The geometric properties of space-time that play such an important role in relativity are easier to understand by analogy to ordinary three-dimensional space.

In three-dimensional space all points are related to one another by geometry. The rules that describe how points relate to one another in flat space are the familiar rules of Euclidian geometry. In this type of world the shortest distance between two points is a straight line.

In curved space the laws governing the relationship between points are those of non-Euclidian geometry. On a sphere, for example, the shortest distance between two

Diagramming Space-Time

Astronomers plot the four-dimensional path of particles or light through space-time on a space-time diagram. In such a diagram, time is plotted against one of the three space coordinates, the axes are labeled so beams of light travel at 45° angles, and the observer's current position — the "here and now" — is at the origin of the diagram. Because material particles must travel slower than the speed of light, they are confined to the past and future light cones; the areas labeled "elsewhere" cannot affect or be affected by the here and now.



points is not a straight line. Instead, distance is shortest along the arc of a circle that is centered at the center of the sphere and passes through the two points.

In space-time all events are related to one another by relativity. In flat space-time the relations are governed by special relativity and in curved space-time by general relativity.

The Space-Time Diagram

Just as space can be represented on a map, space-time can be represented on a space-time diagram. An observer's current location in space-time marks the origin of the diagram. This is also referred to as "here and now" — here is the observer's position in space and now is the current time.

The horizontal direction in the space-time diagram represents position in one of the three space dimensions, and time is measured along the vertical axis. The area above the space axis represents the future and the area below the space axis the past.

The axes of the space-time diagram are labeled so a given unit along the space axis corresponds to the distance light would travel in the same unit of time. For example, if the first tick on the space axis represents one light-year from "here," then the first tick on the time axis represents one year from "now."

Generally the tick marks on the space axis are at one-meter intervals, and thus the tick marks along the time axis are at intervals of time that correspond to the light-travel time across one meter, which is about 3.3 billionths of a second or 3.3 nanoseconds. This small time interval is conveniently referred to as one meter of time or simply one meter. The units really don't matter though, they're simply whatever we find convenient to use.

A space-time diagram can be used to plot the movement of particles or light through the events of space-time. (The path of an individual particle or light ray is known as a world line.) Because light travels one meter in one meter of time, light paths always trace 45° angles on the diagram. Material particles must travel slower than the speed of light, so they always advance on world lines that are steeper than 45°.

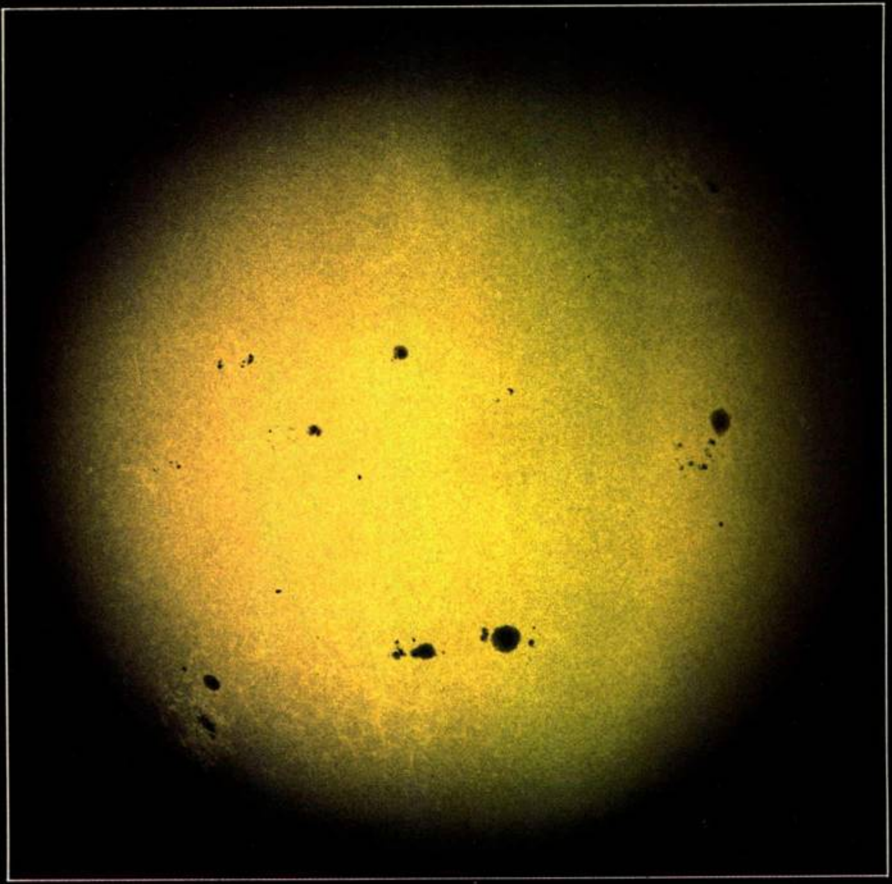
The regions of a space-time diagram bounded by the 45° world line of light and stretching into the future and past are, respectively, the future and past light cones. All events in the future light cone can be influenced by the observer at here and now. The observer can theoretically travel to any of the events or send light to them. Events in the past light cone could have sent particles or light to the observer at here and now. Events outside the light cones are "elsewhere," because to travel from any such event to here and now would require a speed greater than the speed of light. Likewise, these events are unreachable from here and now.

Space-time diagrams become distorted in curved space-time and are not as simple to interpret. The light world line can only be drawn at a 45° angle to the axes for the local region of space-time, and assigning one meter of distance along the straight line representing the space axis is not possible.

The Underlying Physical Basis

Einstein was motivated to develop the general theory of relativity by his conviction that any law of nature should be the same from the point of view of any observer in space-time. In other words, a law of nature should take the same mathematical form in any system of labels used to map space-time. (Such mapping systems are referred

How Starlight Loses Energy



Gravitational redshift is a subtle effect. The energy light loses (the amount light is redshifted) when emitted in a gravitational field is generally overwhelmed by larger effects — Doppler shifts caused by the motion of gas in a star's atmosphere or the motion of the star with respect to Earth, for example. Einstein proposed the gravitational redshift as a test for general relativity in 1907 but did not realize how difficult the gravitational redshift would be to measure accurately.

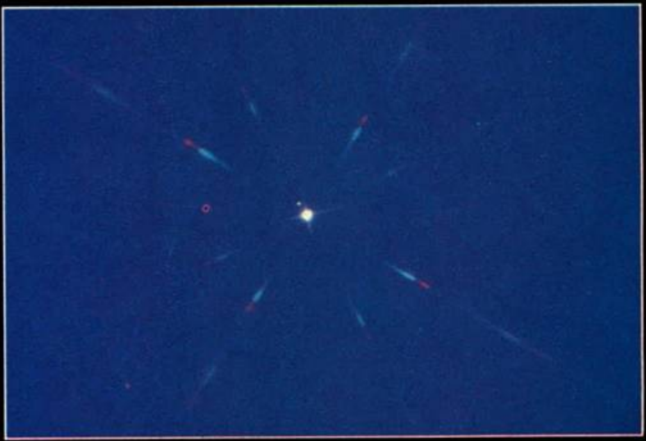
Gravitational redshift is a consequence of the principle of equivalence. To see how, imagine yourself in a uniformly accelerating spaceship. Now have a friend at the back of the ship send a beam of light to you in the front. Because the ship is accelerating, your speed increases while the beam of light is in flight. Thus, when the beam arrives, you are traveling faster than your friend was when he sent the beam. The relative velocity between the two of you causes the beam of light to be redshifted by the Doppler effect.

The principle of equivalence says that an experiment conducted in a uniformly accelerating reference frame must give the same result if performed in a gravitational reference frame. Therefore, the experiment you just performed is equivalent to one in which light is emitted in a gravitational field — the light emitted must be redshifted, which means it has a lower energy.

Astronomers first looked for a gravitational redshift on the Sun. It proved difficult to detect, however, because Doppler shifts caused by the Sun's dynamic atmosphere mask the much smaller effects arising from gravity.

A more likely place to see gravitational redshifts is white dwarf stars. With nearly the same mass as the Sun but a radius smaller by a factor of one hundred, the redshift from a white dwarf should be about one hundred times greater than that from the Sun. The best white dwarf observations today have confirmed Einstein's prediction to within about 20 percent.

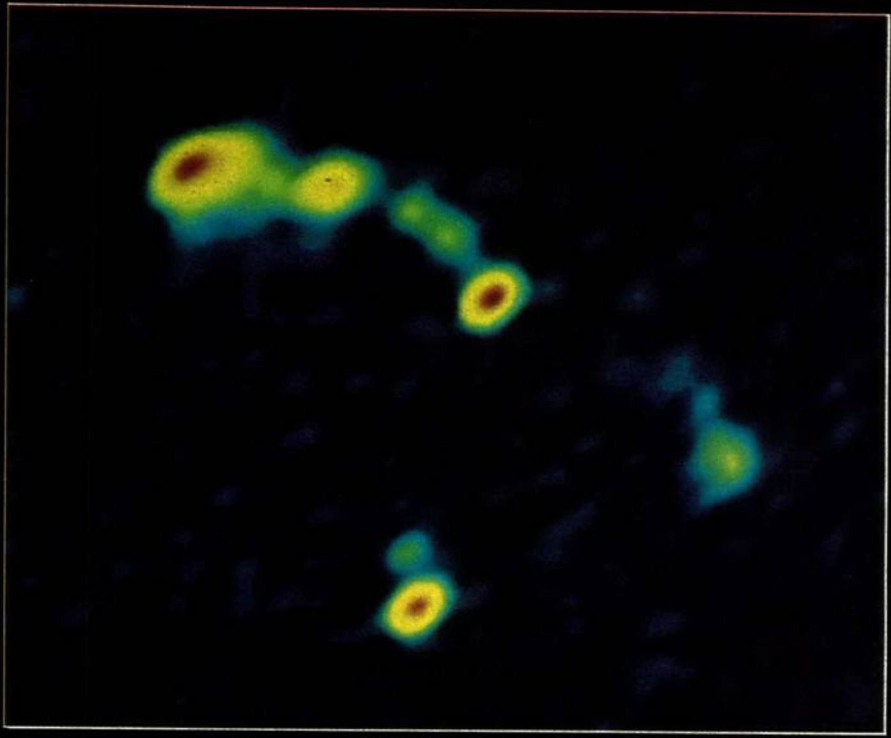
By far the best confirmations of the gravitational redshift have been made right here on Earth. Although the gravitational redshift induced by Earth's gravity is only three parts in 10^{15} (while that from the Sun is two parts in a million), terrestrial observations can be made much more accurately. Today with clocks of ultrahigh stability the gravitational redshift on Earth has been verified to within 0.02 percent of Einstein's prediction.



Top: White light photo of the Sun by Andrew Steinbrecher.

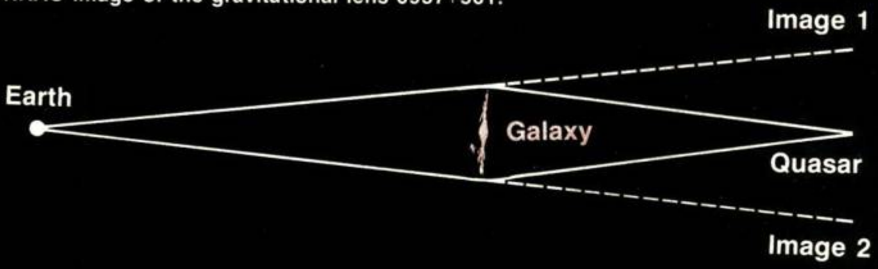
Above: White dwarf Sirius B (to upper left of Sirius A) photographed by Deborah Byrd.

Warped Space-Time and Distorted Images



NRAO image of the gravitational lens 0957+561.

A large curvature of space-time becomes a gravitational lens when it deflects light from a more distant object into two or more images. In the case of 0957+561, a massive galaxy acts as the gravitational lens, bending light from a remote quasar into two identical images.



The Sun warps space-time near itself. As the largest member of our solar system, our star affects the geometry of space-time more than any other nearby body. And, because the effects of general relativity depend on the amount of curvature in space-time, we look to the Sun for the most clear-cut tests of Einstein's theory.

Einstein was aware that his general theory of relativity did not make many observational predictions. The theory solved the mystery surrounding the perihelion shift of Mercury but predicted only two effects that might be observable with the technology of the 1910s: the gravitational redshift and the deflection of starlight. Because the gravitational redshift proved to be beyond the observational capabilities of the time, measuring the deflection of starlight became the prime experimental task.

The general theory of relativity differs from Newtonian theory in one very important way: In Newton's view electromagnetic radiation was unaffected by gravity, while in Einstein's view the path light follows is influenced by the curvature of space-time — gravity.

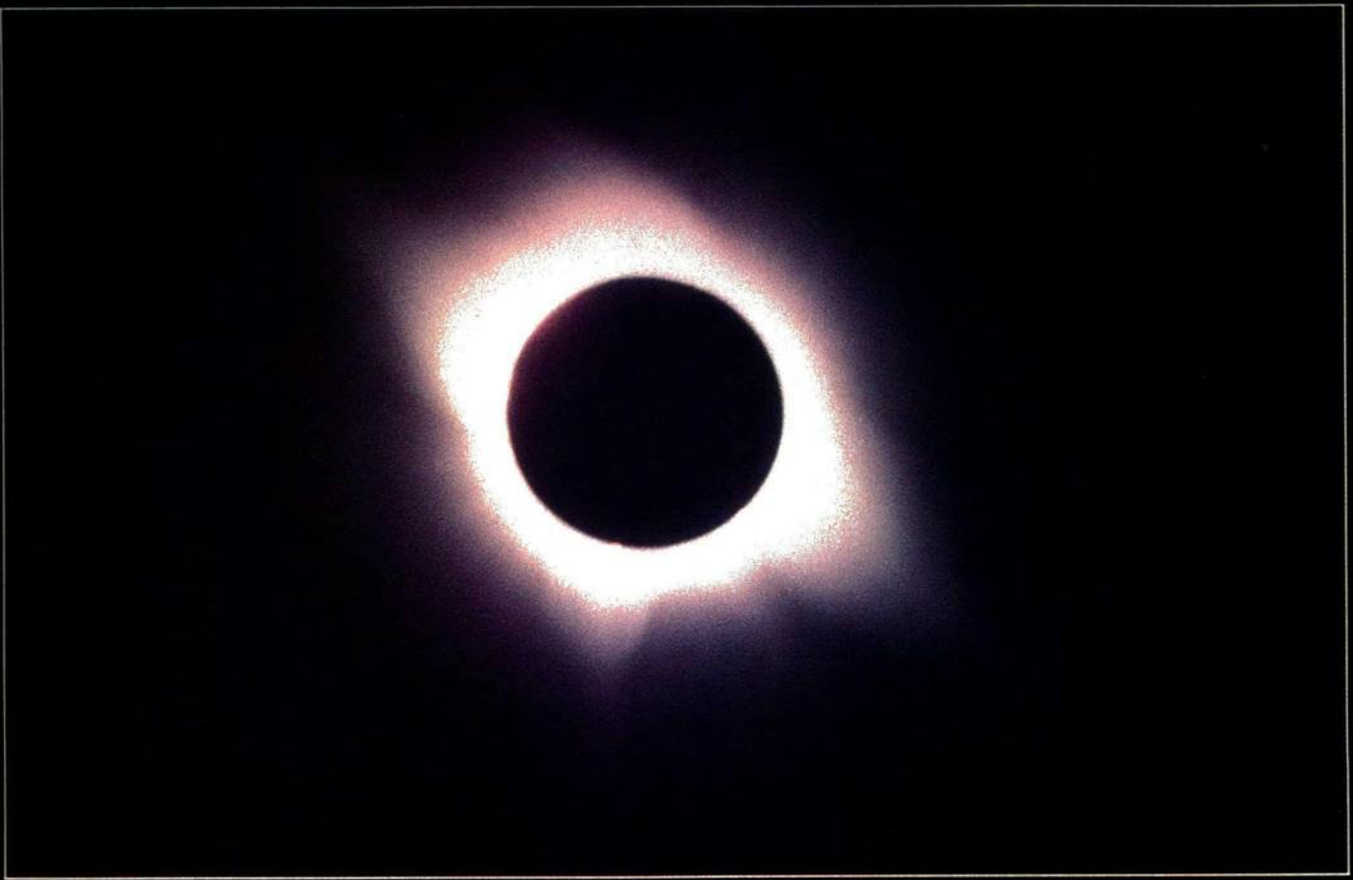
Einstein claimed that the curvature of space-time induced by the Sun would distort our view of objects lying behind the Sun. Essentially, the apparent positions of these objects would change depending on the location of the Sun. If a light ray just grazes the limb of the Sun, the deflection reaches a maximum of 1.75 arcseconds, while the amount of deflection drops off the farther away the object is from the Sun.

Of course, observing stars at the limb of the Sun is usually impossible. Only when a total solar eclipse blocks the solar glare can astronomers see stars near the Sun. Einstein suggested that just such an eclipse observation could confirm the deflection of starlight.

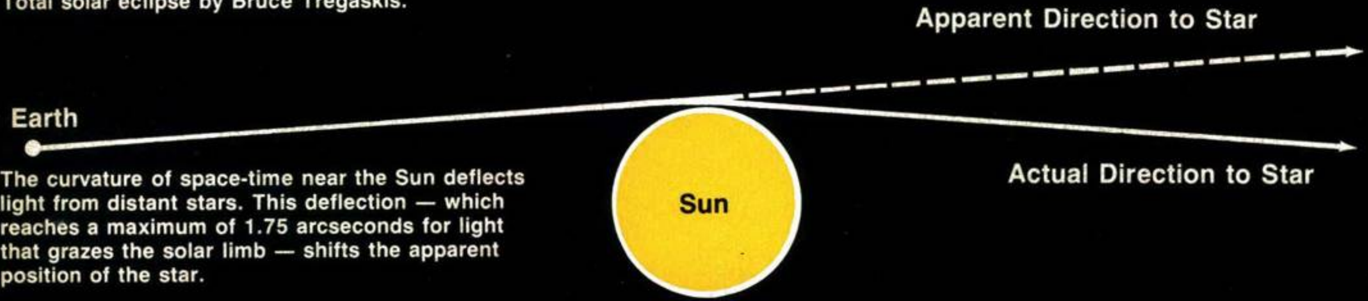
To search for this effect, the British launched two expeditions to the eclipse on May 19, 1919. They compared photos taken on the day of the eclipse to photos of the same starfield without the Sun present and found the deflections occurred and were in rough agreement with the deflections predicted by Einstein. More than any other single event, this confirmation of general relativity helped make Einstein famous.

Astronomers continued trekking to total solar eclipses to test the deflection of starlight by the Sun. Although all these expeditions found some deflection, there were disagreements about the magnitude of the deflection. After more than half a century of observations the deflection was only verified to within 25 percent.

But observational techniques have improved, and there are new ways to measure the deflection caused by the Sun's curving of space-time. Each year on or about October 8, the radio quasar 3C 279 passes behind the Sun. Because 3C 279 is located close to another radio quasar, 3C 273, radio astronomers can monitor the angular separation between them as 3C 279 disappears behind the Sun. By making the observations at radio



Total solar eclipse by Bruce Tregaskis.



The curvature of space-time near the Sun deflects light from distant stars. This deflection — which reaches a maximum of 1.75 arcseconds for light that grazes the solar limb — shifts the apparent position of the star.

wavelengths, astronomers can use interferometric techniques to measure the quasars' separations very precisely and from this determine how much 3C 279 is deflected. The deflection measured by this technique is within 1 percent of the value predicted by general relativity.

The Sun is a fairly small object in the scale of things in the universe, and its effect on space-time is correspondingly small. How does an object with a large effect on the geometry of space-time affect our perception of more distant objects along the same line of sight?

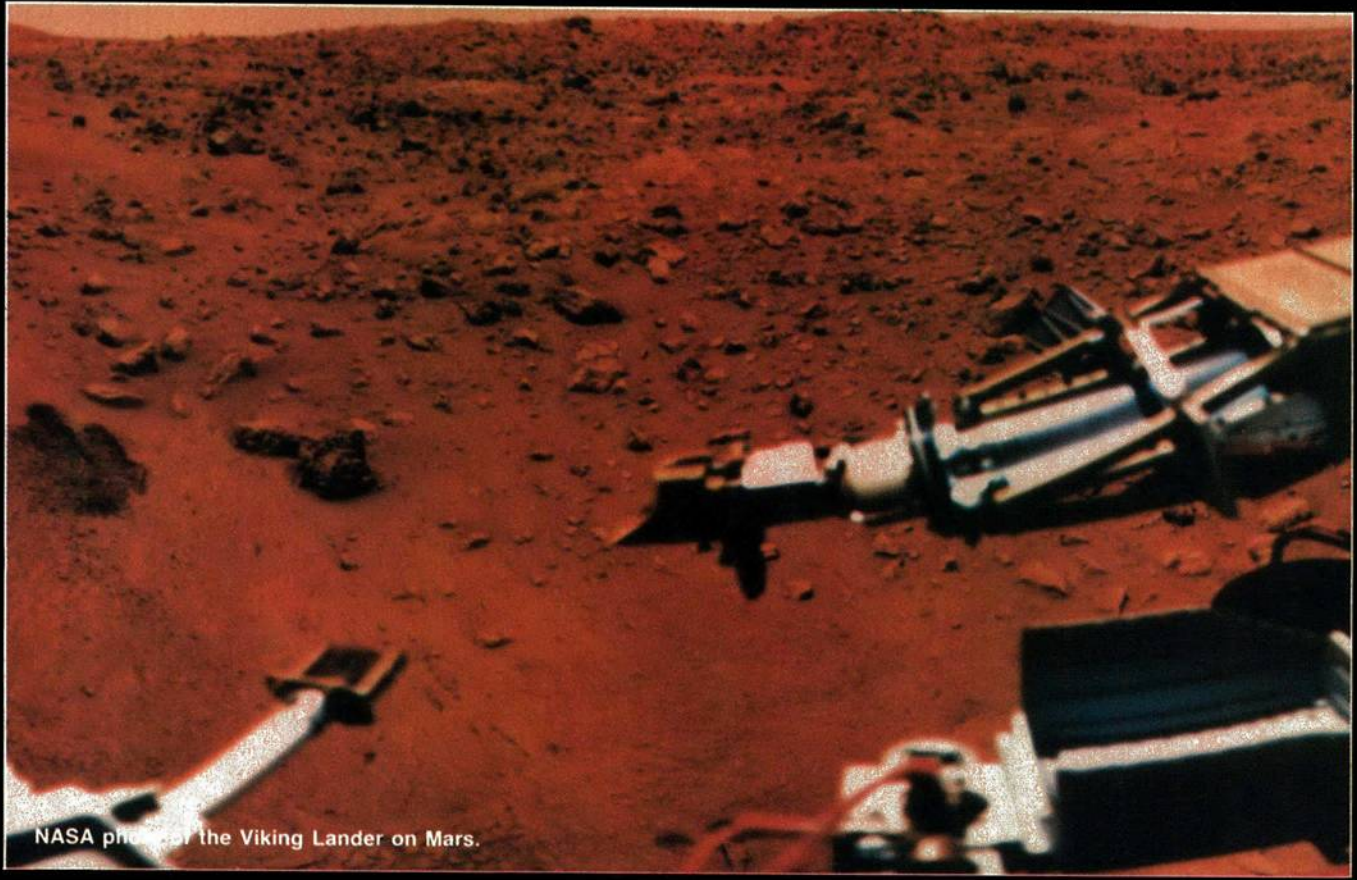
If the geometry of the situation is right, the intervening object can act as a lens and form multiple or distorted images of the more distant object. This "gravitational lens" effect was first predicted in 1936 by Einstein himself.

Perhaps even more surprising than the concept of a gravitational lens is the fact that a handful of gravitational lenses have been discovered. The first one, designated 0957+561, turned up as a pair of quasar images 6 arcseconds apart. Each quasar image has exactly the same redshift, both have nearly identical spectra, and radio observations show that they have very similar shapes. Extensive observations of the area later revealed the faint image of a massive elliptical galaxy between the quasar images, just the kind of geometry expected for a gravitational lens.

Not only have gravitational lenses confirmed another prediction of general relativity, but they may yield valuable clues about the universe. By analyzing the way light passes through the lensing object, a fairly detailed description of the structure of the intervening object can be made. This type of information is just not available for most galaxies at this distance, because the galaxies appear much too faint. Also, because the light in each image follows a different path and because each path is a different length, we can actually observe the quasar at two different times. This can give us important information on the structure of the lensing object and on the distance to the quasar.

When Einstein developed the general theory of relativity, he envisioned that matter would warp space-time and therefore that starlight passing near the disk of the Sun would be slightly deflected. Little did he realize that the exact same effect would open a new window onto the nature of the most distant objects in the universe.

Taking the Slow Path Home



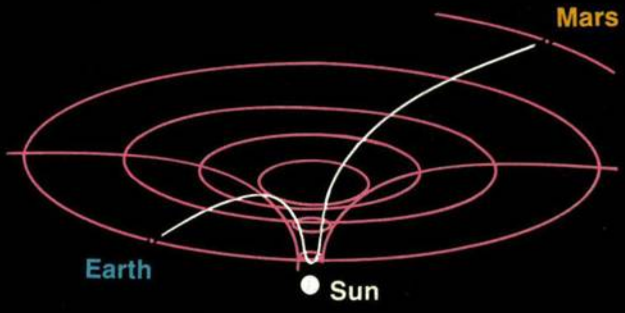
NASA photo of the Viking Lander on Mars.

The most precise confirmation of general relativity's effects has come from the accurate timing of radar signals bounced off planets and space probes. The curvature of space-time not only deflects electromagnetic radiation (see "Warped Space-Time and Distorted Images" on page 12) but also delays it. The closer the signals pass to the Sun, the greater the time delay. The delay is due to the difference between the actual path of the radiation through curved space-time and the imaginary straight-line path that would exist in the absence of space-time curvature.

By working with radar signals in the solar system, astronomers can measure the exact length of time it takes the signal to travel to a planet or spacecraft and return. However, they still need some way to determine how long the signal would have taken to travel in the absence of space-time curvature. In practice this difficulty is overcome by taking a large number of measurements, both when the planet or spacecraft is close to the Sun and when it is far away.

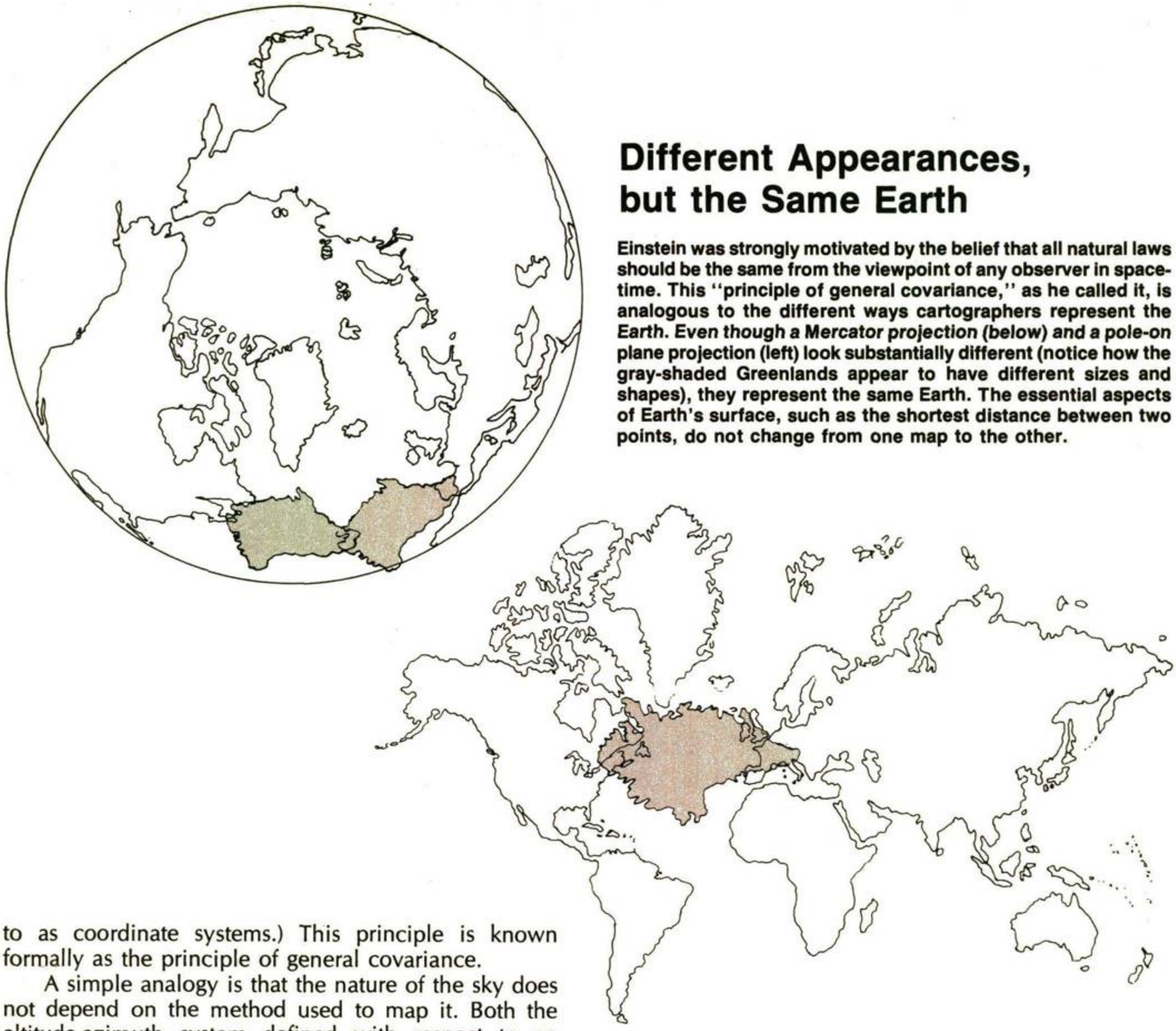
The first attempts at measuring the general relativistic time delay came in late 1966 and early 1967 when Irwin Shapiro (who first described the effect in 1964) and his collaborators bounced radar signals off Mercury and Venus. The delays measured in these experiments generally agreed with predictions but suffered because the returning signals were weak and the topography of the planetary surfaces produced time variations.

Signals sent by the Viking spacecraft to Earth were delayed when they had to pass close to the Sun, because the Sun noticeably curves space-time.



The most accurate tests of this prediction make use of transponders on spacecraft. These devices receive signals and immediately transmit the signals back to Earth. The technique was first applied on *Mariner 6* and *Mariner 7* and later on *Mariner 9*.

But the most precise time-delay measurements were done with the *Viking* spacecraft on Mars. When Mars was on the opposite side of the Sun from Earth, the signals took about 200 microseconds longer to make the round trip than they would have in the absence of the Sun's space-time curvature. This observed delay matches the delay predicted by general relativity to one part in a thousand, the most precise astronomical confirmation yet of Einstein's theory.



Different Appearances, but the Same Earth

Einstein was strongly motivated by the belief that all natural laws should be the same from the viewpoint of any observer in space-time. This "principle of general covariance," as he called it, is analogous to the different ways cartographers represent the Earth. *Even though a Mercator projection (below) and a pole-on* plane projection (left) look substantially different (notice how the gray-shaded Greenlands appear to have different sizes and shapes), they represent the same Earth. The essential aspects of Earth's surface, such as the shortest distance between two points, do not change from one map to the other.

to as coordinate systems.) This principle is known formally as the principle of general covariance.

A simple analogy is that the nature of the sky does not depend on the method used to map it. Both the altitude-azimuth system defined with respect to an observer on Earth and the right ascension-declination system represent the same sky, albeit in two different ways. The method of mapping or labeling does not change any essential aspect of the sky, such as the relative positions of the constellations or the angular separation of two stars.

Einstein's field equations describe the behavior of space-time — whether or not it is curved, and if so by how much. This curvature, which depends on the presence of matter and energy, has nothing to do with the way space-time happens to be mapped or arbitrarily labeled with coordinates.

The field equations, which mathematically describe the general theory of relativity, are laws of space-time and not laws of labels. Labels merely map space-time, and the space-time exists whether labels are there or not.

Gravity and Acceleration

Equally important in the development of general relativity was Einstein's recognition that gravity and acceleration are equivalent. Evidence for this began accumulating with the experiments of Galileo. Galileo showed that all objects, regardless of their masses, fall to Earth at the same rate.

Newton explained these observations by saying that although Earth's gravity attracts more massive objects with a greater force than less massive ones, that extra force just compensates for the heavy objects' greater inertia. The rub came because there are two masses involved: the mass that gravity acts on is gravitational mass and the mass that resists acceleration is inertial mass.

Experiments since Newton's time have shown that gravitational and inertial mass are indistinguishable down to the accuracy of the measurements. Einstein took this observational fact and elevated it to a cornerstone of the general theory of relativity — the principle of equivalence. This principle says that gravitational frames of reference, or coordinate systems, are equivalent to accelerating frames of reference. This implies that falling freely in a gravitational frame is equivalent to being suspended in deep space far from any masses.

Einstein used thought experiments — idealized experiments conducted in the mind to illustrate certain aspects of a situation — involving imaginary elevators to show the arbitrary geometric character of gravitational reference frames. For example, imagine a small elevator resting on Earth's surface. If an occupant of the elevator measures the acceleration — the rate at which velocity changes — of a falling object, he will find a value of 1 g, or

The Expanding Universe

The most important observational fact in cosmology is that the universe is expanding. In every direction we look, we observe galaxies receding from Earth, and the farther away the galaxy is, the faster it travels. That general relativity foretold an evolving universe is probably the theory's greatest single prediction; that Einstein would not accept it is one of his greatest mistakes.

Einstein first applied the field equations of general relativity to the universe as a whole in 1917. At that time astronomers generally perceived the universe as static and unchanging. However, the field equations of general relativity predicted that the universe would instead be dynamic — either expanding or contracting.

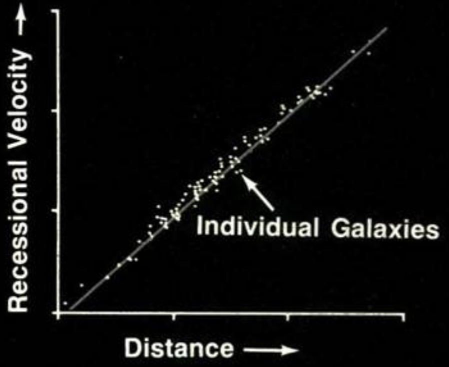
Einstein had a choice: accept that the universe was permanent, according to the dogma of his time, and modify the equations, or accept the field equations and predict an evolving universe. He chose the former path by introducing an additional term — which contained the "cosmological constant" — into the field equations. This term counterbalanced the attractive force of gravity so the universe would remain static.

Other researchers were less bothered by an evolving universe and carefully explored alternate solutions to the field equations over the succeeding ten years. Dutch astronomer Willem de Sitter, Russian mathematician Aleksandr Friedmann, and Belgian astronomer Georges Lemaitre each examined models for an expanding universe — although Friedmann's model was the only one that dropped the cosmological constant altogether — and each of the models predicted that an object's velocity of recession should be proportional to the object's distance.

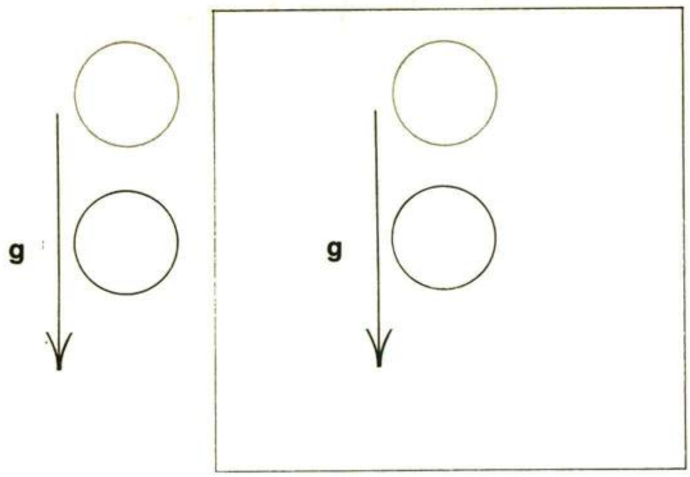
In 1929 American astronomer Edwin Hubble established that the velocity of recession of a galaxy is proportional to its distance, out to 6 million light-years. By 1931 Hubble and his Mount Wilson colleague Milton Humason had published the results of a far more extensive study, which showed that the same relation holds out to distances ten times greater than the first survey had covered.

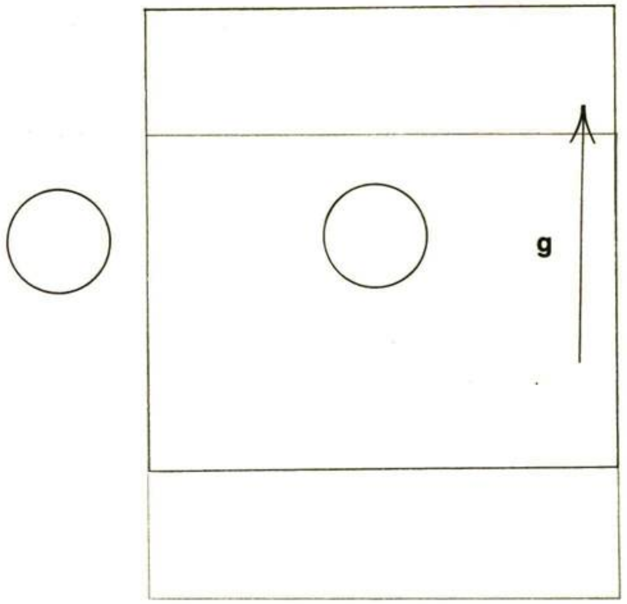
The evidence was in — the universe was expanding. Einstein proposed in 1932 that the simplest assumption should be made: The cosmological constant should equal zero. Then he returned to his original field equations. Later Einstein went even further, calling his introduction of the cosmological constant "the biggest blunder of my life."

Top: A cluster of galaxies in Perseus. Kitt Peak National Observatory photo.



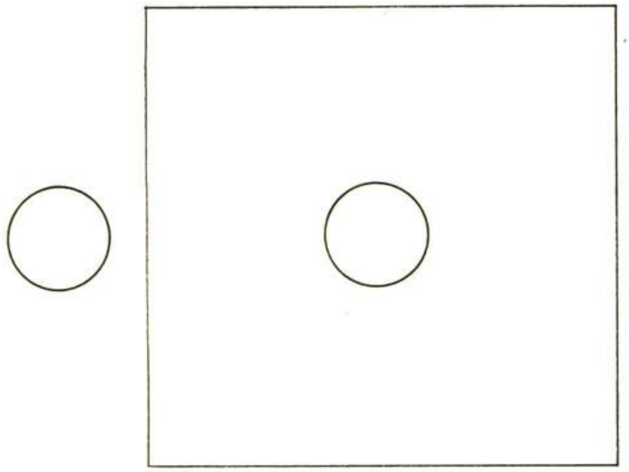
Right: The greater a galaxy's distance from Earth, the faster it appears to be receding from us. This is the observational basis for an expanding universe — a universe that Einstein could have predicted from the field equations of general relativity.

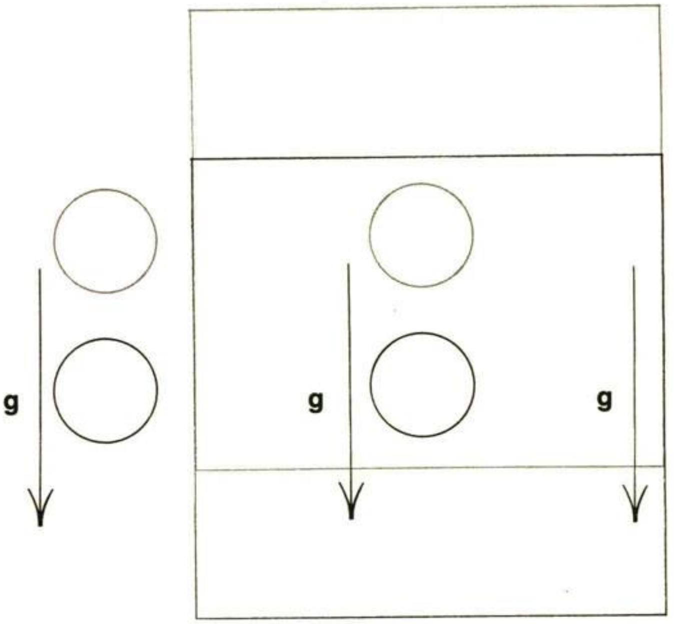




Gravity is Equivalent to Acceleration

Imagine an elevator at rest on Earth (above) and one accelerating through space at a rate of 1 g (above right). At the end of equal time intervals (from the gray to the black shade) the balls inside the elevators both "fall" an equal distance. Now imagine an elevator in deep space with no forces acting on it (below) and one in free-fall above Earth. Again the balls exhibit the same behavior. Einstein performed "thought experiments" such as these to prove that gravity and acceleration are indistinguishable.





32 feet/second/second. Now imagine a similar elevator accelerating through space toward some distant galaxy at the same rate of 1 g. If an occupant of this elevator drops an object, the floor of the elevator will rush up at 32 feet/second/second to meet the object. From the observer's point of view the object behaves exactly the same way the object in the Earth-bound elevator does. These two situations are indistinguishable: there is no way to differentiate between the gravitational frame of reference and the accelerating frame of reference.

Now consider a second pair of elevators: one suspended in deep space and the other in free fall. (Imagine this second elevator to be the cabin of the space shuttle.) Because every object in the second elevator falls at the same rate, there is no apparent force acting on the objects — the same situation that causes astronauts on the space shuttle to appear weightless. The suspended frame and the free-fall frame are also indistinguishable. Frames of reference, such as the elevators in these thought experiments, are the same as coordinate systems or labels.

That gravity can be mimicked inside an accelerating spaceship or that deep space can be mimicked in a freely falling elevator is no accident. In fact, the word mimic is not strong enough, because these apparently different frames are indeed equivalent. No experiment can distinguish one from the other. The force of gravity is really an effect of coordinates: there is no "force" of gravity. Matter moves along natural paths, called geodesics, which in turn are embedded through contours of space-time. Geodesics follow the curvature of space-time induced by the distribution of mass and energy within the space-time.

Free fall is the natural state of matter. The falling object is simply following the natural curvature of the geometry of space-time along a geodesic. Because geodesics follow the curvature of space-time, they represent the shortest possible distance between any two events in space-time, just as a straight line represents the shortest possible distance between two points in space. In a sufficiently small region of space-time the geodesic between two events follows a flat trajectory, even though on a global scale the space-time may be curved.

The principle of equivalence can be summed up this way: It is always possible to find a sufficiently small region of space-time that is locally flat. With this principle Einstein was able to generalize the laws of special relativity that work in flat space-time to the broader arena of curved space-time.

Richness, Elegance, and Simplicity

The concept of 4-D space-time, the principle of general covariance, and the principle of equivalence are the major stepping stones Einstein used to arrive at the general theory of relativity. No equations in physics are as simple to write yet as subtle, complex, and far-reaching in the consequences of what they describe as the equations that describe general relativity. The Einstein field equations elegantly describe nature's most obvious yet most paradoxical and seemingly mysterious phenomenon: gravity.

The field equations are actually ten equations that can be written in a combined form as one equation:

$$\mathbf{G} = 8\pi\mathbf{T}$$

G is a measure of the curvature of space-time and **T** is a measure of the stress-energy content of space-time, where stress-energy is a more generalized form of our familiar mass and energy. Stress-energy in the context of general relativity can take a variety of forms — not only are mass and energy included but also anything else that can produce curvature. Curvature itself is a form of stress-energy, so in effect curvature produces curvature. Another way of looking at this is to say that gravity begets gravity!

The field equations describe the curvature induced by the distribution of stress-energy and how stress-energy generates curvature in space-time. From the equations a wide range of physical phenomena and subsequent observational and experimental predictions can be described.

When Einstein published the general theory of relativity, he explained only one observed phenomenon that Newton's laws had been unable to explain: the precise shift in the orientation of Mercury's orbit. Einstein also predicted two other effects arising from general relativity: the bending of starlight by the Sun and the gravitational redshift of light.

The Quest for Gravity Waves

Supernova 1987A. European Southern Observatory photo.

Many predictions made by the general theory of relativity have been confirmed by sophisticated experiments, but there are still a few areas where experiments are not yet sensitive enough to directly verify a predicted effect. Gravitational waves are one example.

A gravitational wave is a ripple in the curvature of space-time that travels at the speed of light. The distribution of mass and energy determines the geometry of space-time, so any movement of mass or energy will change the geometry of space-time. This creates a disturbance that propagates through space-time as a gravitational wave.

The larger the disturbance, the stronger the gravitational wave, and the more likely it will be registered in a laboratory experiment. The most obvious candidate for a strong pulse of gravity waves is a supernova explosion because of the enormous mass involved and the great speed of the collapse. Despite efforts to detect this radiation on Earth, there have been no positive identifications of gravitational waves, probably because the deformation they cause in objects they pass through is too small for our present technology to detect.

Nonetheless, we have strong *indirect* evidence for the existence of gravity waves in the binary pulsar. Known as PSR 1913+16, this binary system contains a pulsar and another, presumably compact star, though the pulsar is the only object visible. The pulsar spins at a very precise rate, and the slight changes that astronomers see in its pulses are due to the motion of the pulsar around the other star. The period of revolution turns out to be about 7 hours and 45 minutes, which means the two stars are orbiting at about 0.1 percent the speed of light.

General relativity predicts that a system like the binary pulsar should lose enough energy from the emission of gravitational waves for the stars to spiral toward each other. This will manifest itself as a shortening of the binary's period, and that is just what is observed. As the pulsar is followed over a longer period, the amount of the energy loss will become better known, and even more accurate tests on the validity of the gravitational wave predictions will be possible.

Black Holes: The Ultimate in Space-Time Curvature

Some scientists view black holes as the ultimate end to stellar evolution, others as the source of high-energy x-rays in binary systems, and still others as the power source behind active galaxies. How can one type of object take on so many different characteristics? How can a theoretical concept with no observational proof generate so much interest?

Black holes are regions of space-time that have been cut off from the rest of space-time. The "event horizon" is the boundary where escaping from the black hole requires a velocity equal to the speed of light. Outside the event horizon it is theoretically possible to leave the black hole, but once inside the horizon there can be no escape. At the center of the black hole is a singularity, the point at which all of the black hole's mass is concentrated. Singularities are the only places in space-time where the general theory of relativity does not apply.

Black holes come in many sizes from microscopic black holes left over from the start of the universe, through black holes of stellar mass that form when a star collapses at the end of its life, to supermassive black holes that may reside at the centers of some active galaxies.

But black holes are difficult to detect because we see them only through side effects, not directly. If a black hole belongs to a binary system, gas from the companion star can get sucked into the black hole. If that happens, the gas is heated to very high temperatures and emits x-rays. If a large x-ray flux seems to be coming from an invisible star in a binary system and orbital calculations indicate this star has a large mass, then the black hole is revealed. Two of the most promising candidates for black holes lie in such binary systems: Cygnus X-1 and LMC X-3.

Black holes with over a million times the mass of the Sun may lurk in the centers of galaxies and quasars. Any gas that gets drawn into such a black hole releases enormous amounts of radiation from a small volume, the major characteristic of active galaxies and quasars.

In spite of good evidence for black holes — in binary systems with unseen, massive companions and in the enigmatic quasars and active galactic nuclei — there is no definitive proof yet for the existence of black holes.

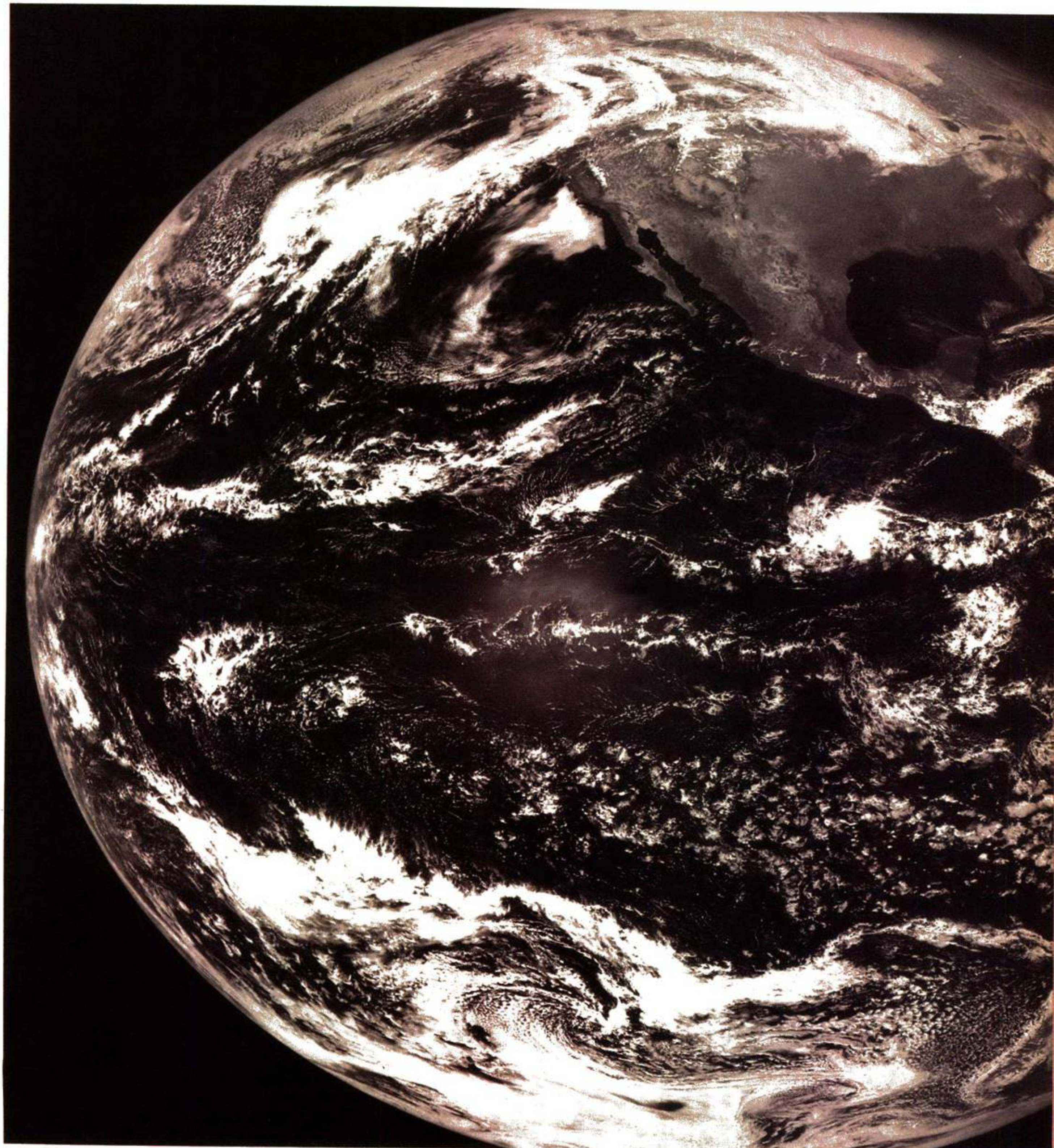
Astronomers tentatively confirmed the bending of starlight during a total solar eclipse in 1919, but the gravitational redshift was not reliably confirmed until a laboratory experiment in 1960. In the intervening years general relativity was not a very active area of scientific interest. Many researchers felt there were not many applications of general relativity, so working in the field would not be productive.

The last quarter of a century has completely changed that view. The discovery of quasars, x-ray binaries, and other energetic processes in the universe seems to require intense gravitational fields — the kind that relativity can explain easily but that are well beyond Newton's theory of gravitation — to explain their violent behavior. Other effects predicted by general relativity were widely ignored because they seemed to be stranger than fiction, but observations of gravitational lenses, for instance, point strongly in the direction of these effects. In the last twenty-five years the level of experimental accuracy has also increased. Now effects that were once nearly impossible to detect — such as the time delay of signals sent skimming past the limb of the Sun — can be checked with accuracies of 1 percent or better.

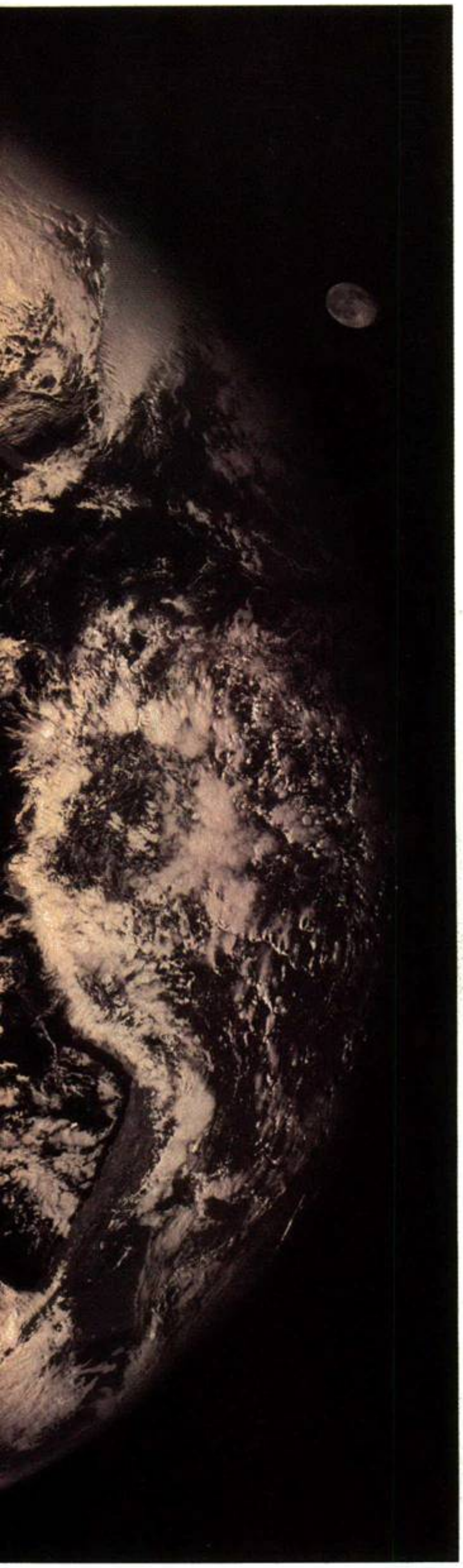
No longer on the outskirts of astronomy and astrophysics, the general theory of relativity is leading us to a better understanding of the nature of our universe and the objects in it. More powerful observational techniques coupled with higher levels of experimental accuracy will continue to test general relativity, which in turn will provide us with greater insight into the workings of the theory. The future looks bright for Einstein's crowning achievement.

James Charles LoPresto is a professor of astronomy at Edinboro University in Pennsylvania. His last article was "The Rotation of the Sun" in the December 1986 issue.

Earth and



Moon Together



by Hank Brandli

It's surprisingly difficult to photograph the Earth and Moon together from space. From the ground the Moon seems big and bright; from the surface of the Moon the Earth is a gleaming presence. But space is big, and there's a lot of empty space between our planet and its one natural satellite. Only when a spacecraft lies near a straight line between them do Earth and the Moon appear close enough to capture on a single frame of film — or within the field of a scanning camera.

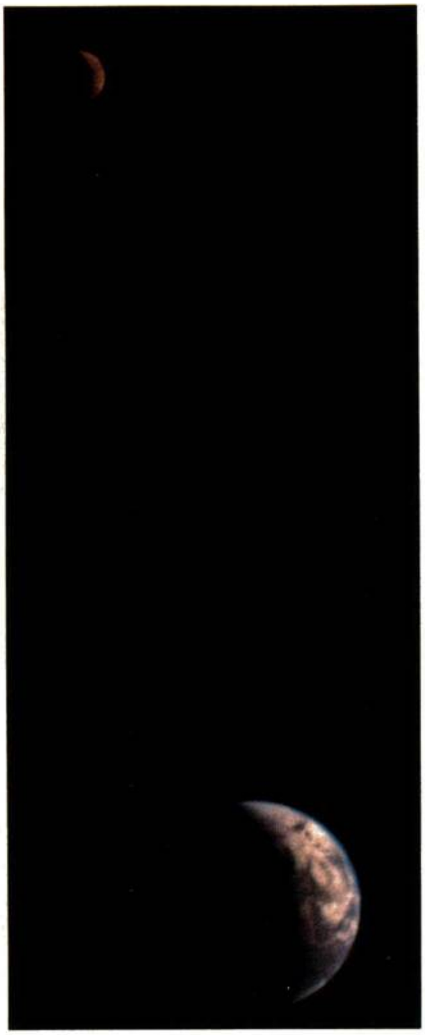
This happens several times each year in early spring and autumn, when our planet, the Moon, and one of several *Geostationary Operational Environment Satellites (GOES)* are in the proper position to allow the sensors aboard the satellite to record the Moon just past Earth's limb.

The distance from *GOES* to Earth is 35,000 kilometers; the distance to the Moon is 415,000 kilometers. No wonder the Moon looks so small — it's over ten times farther from the camera than Earth is. If Earth and the Moon lay the same distance from *GOES*, the Moon would appear one-fourth the size of our world.

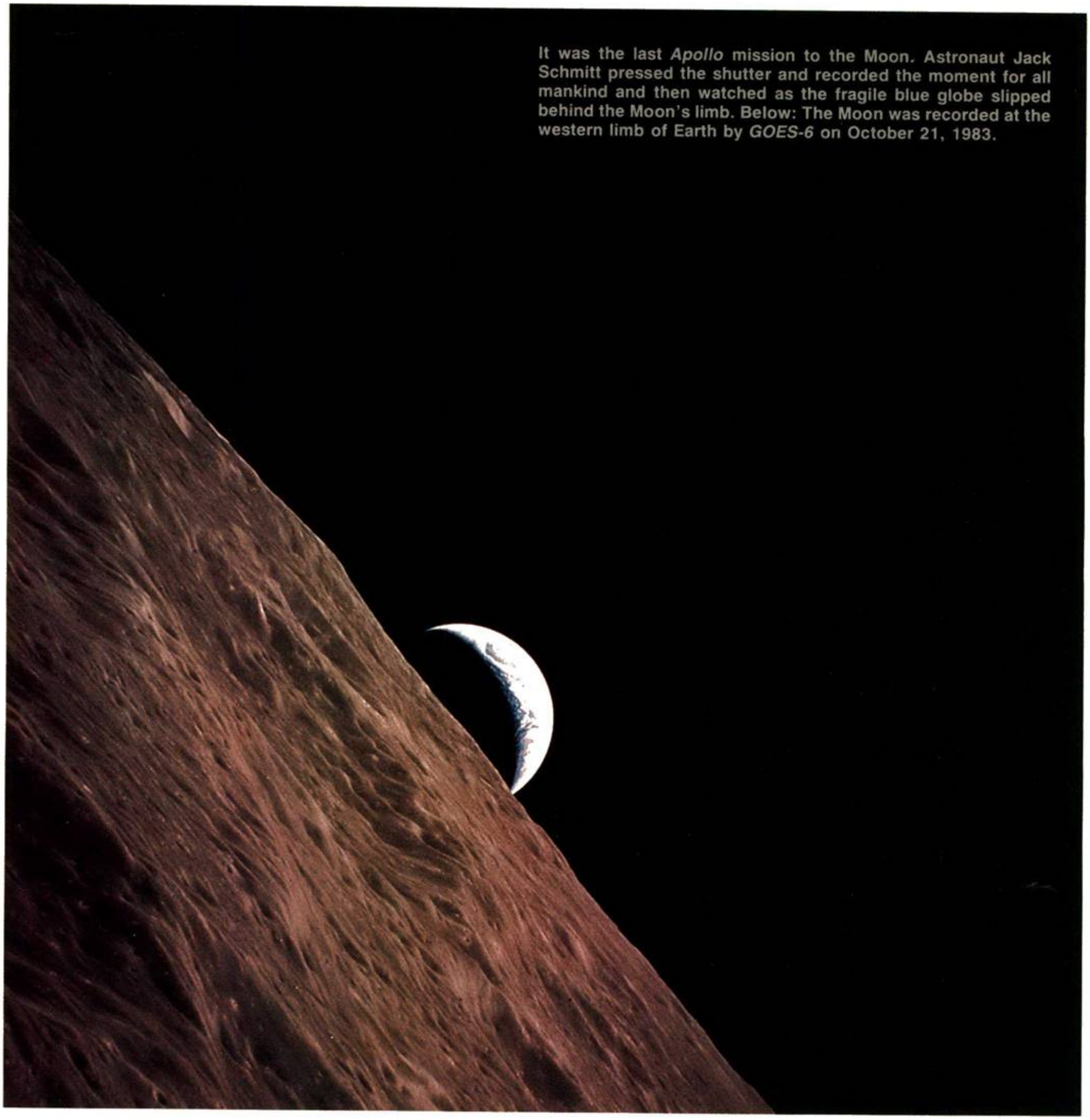
Not only does the Moon appear too small, but it's distorted into an oblong shape. Why? The camera aboard *GOES* is a scanning camera. It does not "snap" a picture and then send it; instead, it starts at the top and "slices" the scene into narrow strips for transmission to Earth. *GOES* orbits Earth exactly once per day, so our planet appears stationary to its scanning camera. As it scans the Moon, though, *GOES* moves in its orbit. Each successive scan is displaced, and on the reconstructed image the Moon looks stretched.

From the Moon, Earth appears four times bigger than the Moon does in the terrestrial sky and a lot brighter. The Moon is actually a dark object — as dark as asphalt. The gleaming white clouds and blue oceans of Earth illuminate the lunar landscape after sundown as no Full Moon ever lit the Earth. From Earth we see this as Earthshine, or "the Full Moon in the New Moon's arms."

In the late sixties and early seventies during the heyday of the *Apollo* program, human beings flew to the Moon and orbited it. With their Hasselblad cameras pointing out the windows of the Command Module and Lunar Excursion Module, they captured Earthrise over the lunar plains and brought those films home for all of us to see. Sometimes it was a blue and white crescent, at others a gibbous swirled marble. The dazzling globe that could be covered with one outstretched hand was our world, our planet, our home. Yet dramatic as the pictures are, they fail to convey the sense



From 22,000 miles above Earth's equator, *GOES* caught the Moon passing behind our world. Taken February 23, 1986, by the *GOES West* satellite. Left: From a range of 12 million kilometers *Voyager 1*'s camera recorded the Earth-Moon system in its true glory. In this highly foreshortened view the Moon is some 380,000 kilometers behind the Earth and thus appears 3 percent too small relative to Earth. NASA photograph.



It was the last *Apollo* mission to the Moon. Astronaut Jack Schmitt pressed the shutter and recorded the moment for all mankind and then watched as the fragile blue globe slipped behind the Moon's limb. Below: The Moon was recorded at the western limb of Earth by *GOES-6* on October 21, 1983.

of a planet and its satellite together in space because the *Apollo* Command Module orbited so close to the Moon.

The best and truest view made so far was taken in 1977, when *Voyager 1*, thirteen days after launch, aimed its camera toward its place of origin and recorded Earth and its Moon in true perspective, the sparkling blue-white world and a dingy brownish satellite one-fourth its size.

Yet even that picture fails to convey a true picture of the Earth-Moon system. Although the Moon appears the correct size relative to Earth (because both objects lay nearly the same distances from the camera), the Moon appears too close to Earth. Both objects lay in nearly the same line of sight, but *Voyager*'s angle of view compressed the apparent distance between them.

The ultimate image, when it is finally taken, will emphasize how tiny the Earth and Moon really are in the vastness of space. On a page of this magazine Earth will glimmer as a pea-size blue crescent in the brilliant light of the Sun. On the opposite page the reader will find our planet's pinhead-size dusky satellite. All around the twin specks of light will be the blackness of space.

Introducing a New 3″ Apochromat:

Oracle™ 3

makes everything perfectly clear

This new 3″ refractor from Tele Vue features a multi-coated triplet objective lens. The resolution and contrast will amaze you! So will the 10x to 200x power range using the celebrated Tele Vue eyepiece line. Imagine a 5 degree field for true "Rich-Field" performance. Plus diffraction-limited, high power capability that's simply stunning!

Use it as a 560 mm f/7.4 telephoto lens or as the ultimate spotting scope. Simple to use and remarkably versatile. 2″ focusser and 2″ diagonal are included. No finder needed. Attaches to standard camera tripods and Tele Vue mounts.

The Oracle 3 is the perfect travelling companion. Its quality is astronomical. Its combination of enormous field, outstanding optical performance and ready-to-go-anywhere convenience is unduplicated.

Visit your favorite Tele Vue dealer to see this Small Wonder. The Oracle 3, *even sharper than you imagined!*

Tele Vue™

20 Dexter Plaza, Pearl River, NY 10965
(914) 735-4044

ASTRONOMY
Forum

Astronomy 101: Alone against the Universe

I was too lazy to take chemistry, too uninterested to take biology, too intimidated to take physics, and too proud to take geography. So, to fulfill the science requirement during my sophomore year at Columbia University, I ended up taking astronomy.

Professor Elmegreen began the first class with the Doppler effect, but my attention was torn between his lecture and the dark-eyed girl next to me. I was amazed by what I was learning.

As the semester progressed my interest in astronomy — and my dark-eyed classmate — intensified. The Sun, which we covered early in the semester, turned out to be considerably more complicated than the "ball of fire" image I had grown up with.

As the leaves turned color, Professor Elmegreen turned off the main sequence of the Hertzsprung-Russell diagram and talked about red giants and white dwarfs. I was lost in this cosmically scaled system. Professor Elmegreen talked in light-years and parsecs while I reasoned in inches and feet. I pushed myself repeatedly but couldn't fathom the dimensions to which he routinely alluded. I began to understand what "astronomical" meant.

That semester while other teachers drew graphs or elucidated literary themes, Professor Elmegreen unraveled the secrets of the universe. When he moved on to relativity and curved space, I sat with my mouth open, caught between fascination and confusion while Professor Elmegreen shared what seemed like privileged, if not classified information.

One night during the semester the university telescope was open to students. I went prepared to see the solar system, which until then I knew only as chalk marks on a blackboard. The telescope stood impressively in the center of the rotating dome, focused on Venus. I bent down, peered into the lens, and saw a glaring, coin-shaped object not much bigger than a tennis ball. I was so disappointed.

As I walked dejectedly back to my dormitory room, I tried to figure out why. I wasn't sure what I had wanted to see, but I hadn't felt the presence I thought the universe ought to command when I looked through the telescope. The telescope with its inanimate insensitivity had taught me a lesson: Exploring the cosmos was a job for my imagination, not my eyes.

In the second half of the course a research paper was required, and Professor Elmegreen said he would be happy if we could show the "slightest inkling of understanding." I was determined to do more than that and chose supernova-induced star formation as my research topic.

I made my way to the physics library and looked up articles in the *Astrophysical Journal*, but I couldn't understand them. It was hopeless. I dragged myself over to the copy machine and copied my articles, so my roommate, a physics major, could translate the equations into ideas I could work with.

Rising above the World

Iran-Contra hearings. Political scandals. Religious leaders falling from grace. Wars raging all over the world. It makes you just want to get away from it all.

Darkness. Nothing around to steal your attention. Nobody around to remind you of the ubiquitous problems. Look up and suddenly you are whisked away from mundane concerns as an unparalleled beauty is revealed to you. That beauty is the star-filled sky, and as soon as your eyes catch it you automatically switch gears and relax.

The night sky remains the best vehicle of escape I know. Psychologists should use astronomy as therapy for patients suffering from anxiety. Simply lying on the grass on a warm July night while staring up at a crystal clear sky takes the weight of the world off your shoulders. As you smell the sweet fragrance of the summer foliage and gaze at the distant stars, you feel yourself lifted as far as your eyes will take you. Out there in space you gain a new perspective on everything.

You begin to see things in their larger, cosmic context. This is far superior to yoga, biofeedback, or any other relaxation technique. Out here you truly feel as if you're part of nature.

All this is not merely an exercise to dull the senses. This is not what Marx would have called an opiate. It is not simply running away from the problems of the world. Instead, being aware of and feeling close to the universe better enables you to deal with the difficulties of this planet once you "come back to reality." It is only when we can see ourselves and our world against the backdrop of the cosmos that we can begin to work together to solve the seemingly unsolvable problems the world faces today. Let's spread the word!

Victor S. Carrano
Astoria, New York

Cambridge University Press

Exploring the Night Sky with Binoculars

Patrick Moore

A painstakingly researched book describing how binoculars can be used for astronomical observation, and detailing the most interesting objects visible in the night sky.

1986/192 pp./30756-2/Cloth $19.95

Leslie Peltier's Guide to the Stars

Leslie Peltier

Written and illustrated to introduce beginning stargazers to the excitement of visual astronomy, this book teaches the reader about the night sky and what one can observe simply by using binoculars.

1986/208 pp./33595-7/Paper $11.95

Meteorites and Their Parent Planets

Harry Y. McSween, Jr.

Provides a comprehensive and readable introduction to the study of meteorites and their significance. Unlike all other books on the subject, which merely classify meteorites, this book explores their origins by tracing meteorites back to the parent bodies.

1987/256 pp./32431-9/Cloth $24.95

Astronomical Observations

An Optical Perspective

Gordon Walker

An up-to-date and comprehensive account of the techniques of optical astronomy available to astronomers at all wavelengths of the electromagnetic spectrum.

1987/400 pp./32587-0/Cloth $79.50/33907-3/Paper $29.95

Now in paperback...

Extraterrestrials

Science and Alien Intelligence

Edited by Edward Regis

1987/288 pp./34852-8/Paper $12.95

Quasar Astronomy

Daniel W. Weedman

Cambridge Astrophysics Series

A unified, up-to-date and practical account of quasar astronomy which summarizes existing results from various techniques, and examines the potentialities of new instruments presently under development.

1986/240 pp./30318-4/Cloth $39.50

The Monthly Sky Guide

I. Ridpath and W. Tirion

An ideal tool to help beginners find their way around the night sky. With maps of the sky for each month of the year, it realistically depicts the stars visible to the naked eye, and uniquely includes a "fist" symbol for comparison as an indication of scale.

1987/64 pp./33921-9/Paper about $7.95

A Catalogue of Southern Peculiar Galaxies and Associations

Halton C. Arp and Barry F. Madore

Volume I: Positions and Descriptions

The largest sample yet compiled of over 6,000 disturbed galaxies: observations of galaxies in collision, galaxies exploding or ejecting material, distorted galaxies, and galaxies in near collision with each other.

1987/216 pp./33086-6/Cloth $60.00

Volume II: Selected Photographic Illustrations of the Classification Theme

Reproduces the most spectacular examples from categories such as: Interacting doubles, triples, and quartets; Galaxies with loops and tails; M51-types with companions on arms; Galaxies with jets; and Peculiar spiral galaxies.

1987/288 pp./33087-4/Cloth $75.00
Two volume set: 34336-4/$125.00

Atlas of Nearby Galaxies

R. Brent Tully and J. Richard Fisher

An essential reference source for all professional astronomers, this unique atlas is the first to present maps of the structure that exists in the distribution in space of the nearby galaxies.

1987/60 pp./30136-X/Cloth $59.50/24 color maps

Forthcoming...

Catalogue of Nearby Galaxies

Astronomical Centers of the World

K. Krisciunas

A thorough introduction to observatories that have made particularly important observational and theoretical advances in the field of astronomy, and to the astronomers who made them famous.

1987/350 pp./30278-1/Cloth about $27.00

Spectroscopy of Astrophysical Plasmas

Edited by A. Dalgarno and D. Layzer

With contributions from foremost experts in the field, this volume presents critical reviews of the current understanding of astrophysical plasmas.

1987/320 pp./26315-8/Cloth $59.50/26927-X/Paper $19.95

Superluminal Radio Sources

Edited by J.A. Zensus and T.J. Pearson

Provides the latest information on the observations and physics of superluminal radio sources.

1987/384 pp./34560-X/Cloth $49.50

Announcing a new series...

Space Telescope Science Institute Symposium Series

Volume 1: Stellar Populations

Edited by C.A. Norman, A. Renzini, and M. Tosi

Presents the review papers from a symposium on Stellar Populations providing a comprehensive summary of our present understanding of stellar populations within galaxies.

1987/270 pp./33380-6/Cloth $32.50

At bookstores or order from

Cambridge University Press

32 East 57th Street, NY, NY 10022.
Cambridge toll-free numbers for orders only:
800-872-7423, outside NY State, 800-227-0247, NY State only.
MasterCard and Visa accepted.

I wanted Professor Elmegreen to be impressed.

When I got the paper back, 99/100 was written on the cover page. I thumbed through the paper, eagerly looking for comments on what I thought was a brilliant paper, but there was none, just a check on the last page. Discouraged, I collected my books and headed for another tedious history class.

Professor Elmegreen ended the course with the beginning — the Big Bang. After the final exam I shook his hand and thanked him for giving me a new frame of reference. He nodded and smiled politely. I knew he didn't believe a word I said.

Over the summer I read a dozen books on physics and subscribed to ASTRONOMY. In September I went back to see Professor Elmegreen. When I got to his office, however, a different name was on the door. The secretary said Professor Elmegreen had taken a job with IBM.

Although I was majoring in philosophy, I worked my way through introductory physics and then more advanced astronomy courses. My philosophy professors weren't interested in physical phenomena or cosmology, however. They held all of physics in contempt for impinging upon philosophy's domain. Later, while I was studying economics in graduate school, my economics professors were jealous of the simplicity of physical theory and cited physics to give their discipline credibility.

So what do I have to show for my persistent interest in astronomy? Perhaps nothing. Would I recognize Einstein's gravitational equations from jibberish? No. Could I pass a course in quantum chromodynamics? No. Do I understand supersymmetry? No. But I do understand how exciting working on these models must be. I enjoy just reading about them and am content to know that somewhere out there men spend their entire lives developing and destroying such models. Men who push their imaginations far beyond what will ever be demanded of most of us. Men waging mental war on the universe itself.

College is only a memory now, but my astronomical education is far from over. I still leave time in my schedule to audit astronomy courses — and I am still seeing the dark-eyed girl who sat next to me on that first day of Professor Elmegreen's class. Maybe the science requirement isn't such a bad idea after all.

Howard M. Steinberg
Yonkers, New York

Breaking 'Aperture Fever'

I started coming down with the malady known as "aperture fever" after I'd been an amateur astronomer for eight years.

When I built my telescope in 1971, the average amateur owned a small refractor or a 6-inch f/8 Newtonian. Back then an 8-inch telescope was definitely big time, so I considered myself fortunate to have a 10-inch f/7 instrument.

I grew less satisfied with it, however, as I gradually learned my way around the sky. I became interested in deep-sky observing and wished I had had the foresight to build something shorter so I'd have a wider field of view and brighter images. I grew even more dissatisfied in the late 1970s when amateur telescopes began to undergo an aperture explosion. I found I no longer had one of the biggest telescopes on the block.

I continued to fight a losing battle with a chronic case of aperture fever that at times became acute. Then the local school district purchased a Celestron 14. Chuck Percival, an astronomy teacher and fellow member of the Southern Colorado Astronomical Society, suggested that we use the C14 as the deep-sky telescope at the public viewing sessions our club sponsored. The other, smaller telescopes could be grouped around the C14 for views of the Moon and the planets.

While this suggestion was not illogical, I was not sure I wanted my telescope to be relegated to just the Moon and planets. Yes, I know a 14-inch telescope has twice the light grasp of a 10-inch and can reach probably a couple of magnitudes fainter, but even though it can't hope to compete with a 14-inch, an 8- or 10-inch is still a good deep-sky telescope.

A bigger telescope is now well down on my list of priorities.

So I resolved that every time I had my telescope at a members-only star party, I would take care to demonstrate its deep-sky capability by finding a few very small, very faint, and very difficult objects. Naturally I practiced finding difficult objects whenever I had the opportunity at home, just to make it easier at star parties.

I'm not sure I ever convinced Chuck of the value of a 10-inch telescope (I don't think he even knew I was trying), but somewhere along the way I convinced myself. I began to notice that difficult objects were not as difficult as they once were and that thousands of objects I had never seen were within reach of my telescope. The more I explored the outer limits of the telescope's performance, the more I realized I had yet to scratch the surface. My respect and appreciation for its capabilities deepened, as did my enjoyment of using it.

Over the past couple of years my wife and I have seen more new things than in the previous ten years combined, including all the planets, several asteroids and comets, and numerous NGC objects of varying degrees of difficulty. We saw Halley's Comet on September 16, 1985, one of the toughest objects I have ever found. We even witnessed and timed one asteroid occultation for the International Occultation Timing Association. I once again consider myself fortunate to have a telescope with the capability it has.

If my case is fairly typical, I suspect most amateurs are not limited so much by their telescopes as by their own ability or willingness to flex their observing muscles. When I contented myself with the Messier list and the bright planets, I often wished for a bigger telescope because there were some things I wanted to see and never had. In most cases, though, it was because I hadn't tried to see them at all or had made only a half-hearted attempt and then given up.

However, now that I have begun to expand my horizons, I seldom feel a need for more aperture. Though the aluminum on my old mirror is getting pretty dingy after fifteen years, that mirror is still capable of showing 14th-magnitude objects. I know if the object I'm looking for is magnitude 13.5 and I can't find it, I don't need a better telescope as badly as I need better observing skills.

This doesn't mean I wouldn't care to have a bigger telescope someday or that there is anything wrong with wanting one. After all, as far as astronomical telescopes are concerned, bigger is better. It's just that a bigger telescope is now well down on my list of priorities. And if I ever do build a bigger one, it will not be used instead of my current telescope but in addition to it. A larger instrument would probably have to have a shorter focal ratio, and I'm not convinced I would get the crisp, high-resolution images of the planets I have always enjoyed and now also appreciate.

So if you're burning up with aperture fever, spend some time under the stars challenging yourself and your instrument before you get rid of it. Push it to its limit a few times to be sure the limit you reach is that of the telescope and not yours.

Walter Russell
Boone, Colorado

Sooner or later, all of the secrets of the heavens are revealed in the only book club of its kind, the

Astronomy Book Club

Take any 3 books for only $1.00 each

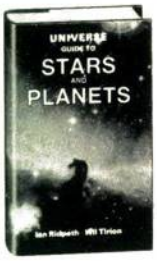
You simply agree to buy 3 more books—at handsome discounts—within the next 12 months.

Values to $59.85

(Publishers' Prices shown.)

Leslie Peltier's
Guide to the Stars
Exploring the Sky with Binoculars

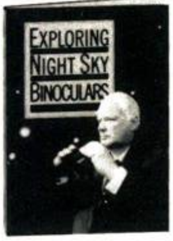
58212 $11.95
(Softbound)


Universe Guide to
Stars and Planets
Ian Ridpath · Wil Tirion

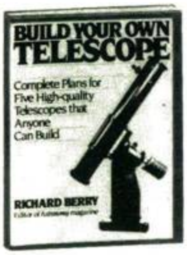
85358 $19.95

Thursday's Universe
Marcia Bartusiak

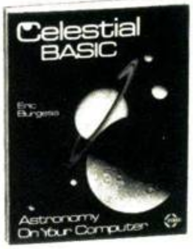
84270 $19.95


Exploring Night Sky Binoculars

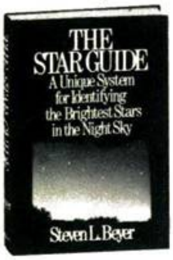
46310 $19.95


Build Your Own Telescope
Complete Plans for Five High-quality Telescopes that Anyone Can Build
Richard Berry

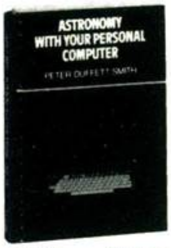
36988-2 $24.95
(Counts as 2 choices)


Celestial BASIC
Eric Burgess
Astronomy On Your Computer

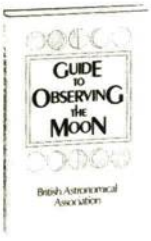
37395 $16.95
(Softbound)


The Star Guide
A Unique System for Identifying the Brightest Stars in the Night Sky
Steven L. Beyer

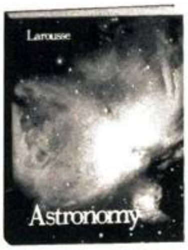
80180-2 $22.95
(Counts as 2 choices)


Astronomy with Your Personal Computer
Peter Duffett-Smith

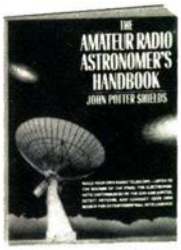
34657 $14.95
(Combound)


Guide to Observing the Moon
British Astronomical Association

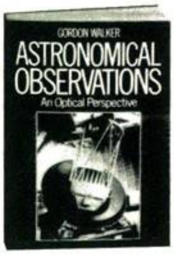
51915 $14.95


Larousse
Astronomy

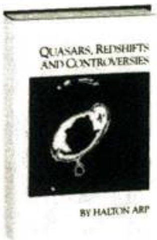
57765-2 $35.00
(Counts as 2 choices)


The Amateur Radio Astronomer's Handbook
John Potter Shields

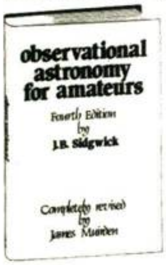
32645 $19.95
(Softbound)


Gordon Walker
Astronomical Observations
An Optical Perspective

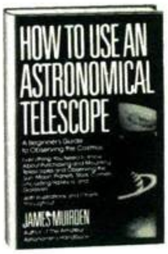
34648-2 $29.95
(Counts as 2 choices)


Quasars, Redshifts and Controversies
By Halton Arp

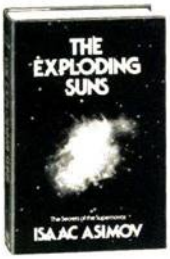
73240 $19.95


observational astronomy for amateurs
Fourth Edition
by J.B. Sidgwick
Completely revised by James Muirden

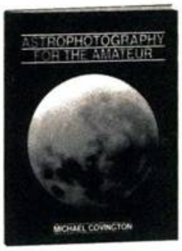
65185 $19.95


How to Use an Astronomical Telescope
James Muirden

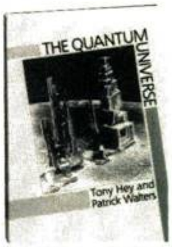
53910-2 $21.95
(Counts as 2 choices)


The Exploding Suns
The Secrets of the Supernovas
Isaac Asimov

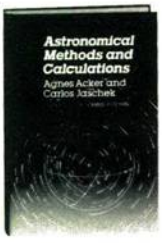
47175 $18.95


Astrophotography for the Amateur
Michael Covington

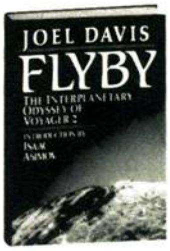
35517-2 $24.95
(Counts as 2 choices)


The Quantum Universe
Tony Hey and Patrick Walters

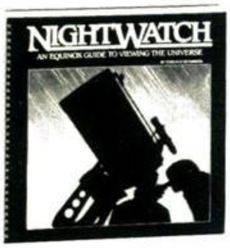
73179 $16.95
(Softbound)


Astronomical Methods and Calculations
Agnes Acker and Carlos Jaschek

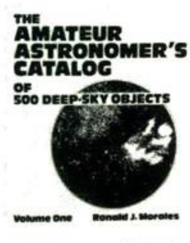
34670-2 $34.95
(Counts as 2 choices)


Joel Davis
Flyby
The Interplanetary Odyssey of Voyager 2
Introduction by Isaac Asimov

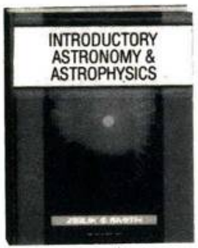
48668 $17.95


Nightwatch
An Equinox Guide to Viewing the Universe

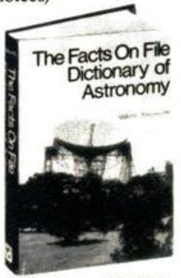
64709 $19.95
(Spiralbound)


The Amateur Astronomer's Catalog of 500 Deep-Sky Objects
Volume One
Ronald J. Morales

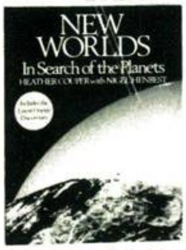
32646 $12.50
(Softbound)


Introductory Astronomy & Astrophysics

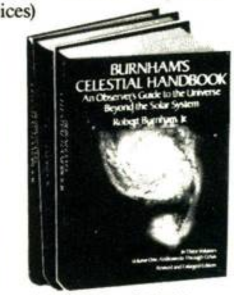
55963-3 $44.75
(Counts as 3 choices)


The Facts On File Dictionary of Astronomy

48085 $19.95


New Worlds
In Search of the Planets
Heather Couper with Nigel Henbest

64627 $12.95
(Softbound)


Burnham's Celestial Handbook
An Observer's Guide to the Universe Beyond the Solar System
Robert Burnham, Jr.

36978-3 $60.00
(3 books count as 3 choices)

MEMBERSHIP BENEFITS • In addition to getting 3 books for only $1.00 each when you join, you keep saving substantially on the books you buy. • Also, you will immediately become eligible to participate in our Bonus Book Plan, with savings of up to 65% off the publishers' prices. • At 3–4 week intervals (16 times per year), you will receive the Astronomy Book Club News, describing the coming Main Selection and Alternate Selections, together with a dated reply card. • If you want the Main Selection, do nothing, and it will be sent to you automatically. • If you prefer another selection, or no book at all, simply indicate your choice on the card and return it by the date specified. • You will have at least 10 days to decide. If, because of late mail delivery of the News, you should receive a book you do not want, we guarantee return postage.

Astronomy Book Club
Riverside, New Jersey 08075

Please accept my application for trial membership and send me the three volumes indicated, billing me only $1.00 each, plus shipping and handling. I agree to purchase at least three additional Selections or Alternates over the next 12 months. Savings range up to 30% and occasionally even more. My membership is cancelable any time after I buy these three additional books. A shipping and handling charge is added to all shipments.

No-Risk Guarantee: If I am not satisfied—for any reason—I may return my introductory books within 10 days. My membership will be canceled, and I will owe nothing.

3 books for $1.00 each:
Indicate by number the books you want.

A few expensive books (as noted) count as more than one choice.

Name________________

Address________________Apt.______

City________________

State________________Zip______

(Books purchased for professional purposes may be a tax-deductible expense. Offer good in Continental U.S. and Canada only. Prices slightly higher in Canada.)

Astronomy 10/87 L-BT9

Seeing a Vampire in the Mirror

One cold, late summer evening in southern Ontario a group of us from the North York Astronomical Association gathered around the campfire to tell optical horror stories while we waited for twilight to end.

I'm an optician, so I've always been curious about the optical quality of commercial telescopes. I've tested a number of commercial mirrors with a Ronchi grating, a piece of film with a series of lines photographed on the emulsion, and found the optics of these mirrors were not as good as they were supposed to be. In fact, some were terrible.

Once I had tested a Japanese 2-inch mirror star diagonal I bought from a local vendor and found that aluminized window glass had been glued into the assembly. What should have been a straight fringe pattern looked like the Rocky Mountains.

This and other horror stories naturally made some people observing with us that night, who had commercial telescopes, uncomfortable. I soon found out, though, that observers are more uncomfortable about *knowing* they have bad optics than they are about *having* bad optics.

I walked over to where Alex was observing some objects in the Scorpius region with his big Schmidt-Cassegrain telescope, minding his own business. I had my hands in my pockets to keep them warm and to hide a Ronchi grating I was holding.

"Alex, would you mind pointing your telescope at a bright star. I want to try something." He graciously allowed me to interrupt his observing and pointed his big telescope at Altair.

"Would you remove the star diagonal assembly? We won't need it." I removed the Ronchi grating from my pocket and showed it to him.

"This is a Ronchi grating. If I fasten it to the tail end of your telescope, I'll be able to test your telescope's optics and see how good they are."

I was trying to determine the best way to fix the slide mount onto the back end of the telescope when Alex placed his arm between me and his telescope and pushed me back to a safe distance.

"You keep that thing away from my telescope!" he said rather excitedly.

"Alex, relax. All I want to do is test your telescope's op —."

"I don't want to know! I'm happy with my telescope. I don't want you spoiling it. Stay back!"

Alex stood between me and his telescope, arm outstretched, holding me at bay. His stance reminded me of the hero in those old Dracula movies saving the hapless victim from a sure death. All he lacked was a crucifix.

I never realized a person might feel that way. I assumed everyone would want to know how good his telescope is. In the stillness of that moment I saw myself as Alex must see me. I *was* a vampire, ready to suck the lifeblood out of Alex's telescope.

Did I really want to risk destroying his faith in this very expensive instrument? To rip away the foundation of his hobby? What could he do if the optics did indeed turn out to be poor? The telescope was purchased years ago and could not be returned. Would I be prepared to take the responsibility for inflicting this knowledge on him and refigure the optics for him? What does it matter if the telescope's optics are not optimum if the owner is satisifed?

Then I recalled that a fellow telescope maker had told me about testing a telescope with homemade optics at a convention, and though the optics were terrible, my friend didn't have the heart to tell the owner. The fellow was satisfied — in fact pleased — with his accomplishment. Alex is happy with his telescope. It has shown him wonders that few people in this world ever see.

I withdrew my fangs and shoved the grating in my pocket. Not making any sudden moves, I placed my hand on his shoulder.

"Alex," I said as I gently coaxed him back to his telescope, "may I please see the universe through your wonderful telescope?"

Peter Ceravolo
Edmonton, Alberta, Ontario

The Golden Age of Science Is Now

Few things so enchant the curious mind as the fresh-ink smell of a new book. The author invites you into a world of ideas he wants to share.

This anticipation is especially intense with books about science, for there is an immediacy surrounding astronomy, geophysics, evolutionary theory, and related disciplines that makes a first edition with this year's publishing date seem urgent.

I was struck by this immediacy as I read *Planet Earth*, adapted from the Public Broadcasting Service series.

There Vega and Beta Pictoris are revealed, their embryonic planetary disks confirming what we always suspected about solar system accretion.

There is a restatement of the Alvarez hypothesis that comet impacts caused dinosaur extinction, a mention of SETI, a now familiar *Voyager* portrait of Jupiter's Great Red Spot, and a radar-imaged topography of Venus.

Suddenly I stopped reading. All these casually reported wonders date from this decade!

What is going on is absolutely astonishing. For the first time in human history basic questions raised by one generation are being answered by that same generation.

I recall what I'd heard in elementary school: "Someday" men will travel to the Moon. "Someday" we'll know how big the universe is. "Someday" man will command robots.

Someday has arrived. In fact, someday was last month and last year, and it may well be tomorrow afternoon for SETI or the final compilation of a Grand Unified Theory of physics.

All these somedays, suddenly piled on top of one other in a scientific revolution, require that both the layman and the scientist give up the idea that knowledge takes a long time.

It took thousands of years for man to abandon a primitive awe of nature and apply rudimentary reasoning to some fundamental questions — and to find wrong answers in many cases. A millennium elapsed before Copernicus, Kepler, Galileo, and Tycho Brahe dared to upset the twin apple carts of religion and superstition. Even Einstein in the "modern" twentieth century found few buyers for the concept of relativity.

Wait a while, society cautioned. The theory sounds good, but decades will be needed before it's accepted. Go to the Moon in this decade? Aren't we rushing things?

The real scientific revolution of the last quarter of the century is the sudden acceleration of knowledge made possible by thousands of new tools and one ancient one: the human mind.

Soon men or delicate robots will stand upon Mars, and we will postulate ways to make that arid world hospitable.

SETI will snatch a message from the void or rule out the existence of other intelligent civilizations in our backwater galactic region.

A telescope in space will look back into time and measure matter and the very blueprint of our origins.

Of all the ages of human history, ours has the unique privilege of expecting revelations that will enrich *us*, not startle our children or some future generation. The most glittering of all golden ages of man is here. Revel in it.

Mike Brake
Oklahoma City, Oklahoma

Share the Wonders of the Universe With Your Child – Give ODYSSEY!

SPACE EXPLORATION AND ASTRONOMY FOR YOUNG PEOPLE
Odyssey
$2.00
August 1987
LOOK OUT BELOW
MOON COLONY WINNERS
GOT THE CAR TRIP BLUES?

HALF-PRICE OFFER!

Here's the perfect gift for all the youngsters on your holiday list – ODYSSEY, the young people's (ages 8-14) magazine of astronomy and outer space. Take advantage of this special holiday half-price offer – give one subscription at $16, and additional gifts are just $8 each!

With each gift subscription to ODYSSEY, you'll be sharing the beauty and mystery of the universe, and passing on the excitement you felt when you discovered the magnificent night skies!

ODYSSEY's easy-to-read articles explain the cosmos to your child and cover topics ranging from space missions to star clusters. Monthly star charts show your child the changing night sky and projects, games, and puzzles offer the opportunity to participate in exploring the universe. ODYSSEY satisfies your child's curiosity about space and space exploration.

With our special holiday offer, you can bring 12 exciting issues of ODYSSEY to all your young friends. It's a great gift at a great price!

ODYSSEY HALF-PRICE SUBSCRIPTION OFFER

YES! I want to give ODYSSEY to my favorite young people this holiday season. Please enter the following subscriptions:

FIRST SUBSCRIPTION – 12 issues for $16

Child's name

Address

City, State, Zip

ODYSSEY, 1027 N. 7th St., Milwaukee, WI 53233-1471
Please allow 4-6 weeks for first issue.
For convenience, use the ASTRONOMY envelope bound into this issue.

SECOND SUBSCRIPTION – 12 issues for only $8

Child's name

Address

City, State, Zip

☐ PAYMENT ENCLOSED

☐ Bill me later

A gift from

Your name

Address

City, State, Zip 4601

For additional subscriptions at $8 for 12 issues, attach a list of names and addresses. To qualify, half-price subscriptions must accompany a full price "First Subscription." All foreign subscriptions, add $4 payable in U.S. funds.

Incredible Savings on the Bausch & Lomb 4000

Bausch & Lomb 4000 Professional $499

The professional 4" Schmidt-Cassegrain is great for astrophotography and sharp viewing! Features enhanced aluminum primary mirror, silvered secondary mirror, and fully multicoated optics. Includes 2 eyepieces, star diagonal, finderscope, clock drive, table tripod, 2X Barlow lens, 35mm camera adapter, case, and more.

4000 Pro with Wedge & Adjustable Field Tripod $598

Bausch & Lomb 4000 Observatory $449

The affordable and versatile 4" Schmidt-Cassegrain telescope. Enjoy the stars, wildlife, photography, and more. Includes 2 eyepieces, star diagonal, finder, clock drive, table tripod, case, and complete self-instruction guide.

Bausch & Lomb 4000 Wedge & Tripod Special!

Buy the Bausch & Lomb 4000 Pro or 4000 Observatory, and **SAVE $100** on the full-sized wedge and tripod. A $199 list value, with purchase it's only...

$99

While supplies last.

Bausch & Lomb 8001 Professional $1249

The professional 8" Schmidt-Cassegrain system that's light years ahead of its time! Features enhanced aluminum primary mirror, silvered secondary mirror, and magnesium fluoride multicoated optics. Research-grade dual motor right ascension drive provides ultimate precision for all tracking applications. Includes 2 eyepieces star diagonal, 8x50 finder, wedge, adjustable tripod, case, and much more.

Bausch & Lomb Eyepieces

50mm Ramsden	$39
50mm Hastings	$49
32mm Plossl	$59
18mm Symmetrical	$39
16.3mm Erfle	$59
12.7mm Symmetrical	$39
9mm Symmetrical	$39
7mm Symmetrical	$39
6mm Orthoscopic	$59
4mm Orthoscopic	$59
8.38.3-21mm Zoom Orthoscopic	$99
30mm Symmetrical	$39
Pro 35mm Plossl	$74
Pro 26mm Plossl	$74
Pro 17mm Plossl	$74
Pro 10mm Plossl	$74
Eyepiece adapter	$24

Bausch & Lomb RV 5+ Reflector $679

Newtonian telescope designed for the more advanced amateur astronomer. Features a fast f/5.5, 5.1" optical system, three eyepieces, tripod, accessory tray, equatorial mount with slow motion controls, built-in polar axis finderscope, and more. $1299 list.

Bausch & Lomb 4.5" Newtonian Reflector $359

The most aperture per dollar! Excellent for viewing the moon, planets, galaxies, nebulae and star clusters. Includes equatorial mount, tripod, and 3-0.96 eyepieces. $499 list.

New! Bausch & Lomb 3000 Spotting Scope $269

Compact Maksutov-Cassegrain 3.1" spotting scope/telephoto lens that offers versatility and portability...weighs less than 3.5 pounds. Includes star diagonal, 20mm and 12.5mm eyepieces, carrying case, and camera adapter.

Bausch & Lomb Deep Sky Observing Kit $189

Broaden your field of view and capture faint nebulae, galaxies, and star clusters. Includes RFT adapter assembly, 32mm Plossl, nebula filter, accessory case, star charts, and deep sky chart.

Bausch & Lomb Lunar/Planetary Observing Kit $169

Resolve and compare fine planetary and lunar details. Includes series 6 drop-in filter kit, 6mm ortho eyepiece, 12.7mm measuring reticle eyepiece, accessory case, and star charts.

Bausch & Lomb Advanced Observing Kit $139

Expand your viewing capabilities and advance to astrophotography. Includes polar alignment kit, camera adapter, T-mount, 2x Barlow, 10mm Pro Plossl eyepiece, accessory case, and star charts. Adaptable to most Schmidt-Cassegrain telescopes.

Send $2 for the new **National Camera Exchange** **Telescope Catalog!**

Telescopes
National Camera Exchange

New Bausch & Lomb 11x80 Astronomical Binoculars $299

The best in sight! Oversized BAK-4 prisms and full multicoating provide these astronomical binoculars with unsurpassed image quality. Sharp to the edge of the field, with no annoying prism cutoff. Includes tripod adapter, caps, straps, and case.

Bausch & Lomb 20x80 Astronomical Binoculars $299

Bausch & Lomb Accessories

Star Diagonal	$24
Barlow lens 2X	$29
8x50 finder scope	$74
8x50 RA finder scope	$89
6x30 finder scope	$49
RFT adapter assembly	$99
F/5 focal reducer #1	$49
f/7.5 focal reducer #2	$49
Camera adapter 6000/8000	$24
Eyepiece projection tube	$24
Piggyback mount 8000	$39
Dynatracker	$229
Nebula filter 1.25"	$59
Off axis guider, complete	$149
Off axis guider, T-section	$69
9mm Illuminated reticle	$89
Field tripod & wedge, 4"	$159
Camera adapter, 4"	$19
Porro prism	$49
Star diagonal 4000	$24
Solar filter 4000	$109
12.7mm measuring reticle eyepieces	$89
Counterweight set 6000/8000	$39
Spectral dispersion eyepieces	$99
Wedge 4000	$79
Polar Alignment kit	$29
Piggyback Mount 4000	$24
Astrophotography kit	$79
Optics cleaning kit	$24
T to C adapter	$29
Series 6 filter set	$59
Accessory case	$29

Use your **Visa, Master Card, or Discover Card!**

Since 1914

National Camera Exchange +Video

9300 Olson Memorial Highway, Golden Valley, Minnesota 55427
For information, call the telescope experts:
Brad Daniels, Jeff Marshall, or Dennis Quiggle at **(612) 546-6831.**

TO ORDER CALL TOLL-FREE 1-800-624-8107

A star atlas unlike any other . . .

URANOMETRIA 2000.0 Volume 1
The Northern Hemisphere to -6°

URANOMETRIA 2000.0
Volume I
The Northern Hemisphere to −6

Great Gift Idea!

By Wil Tirion, Barry Rappaport, and George Lovi

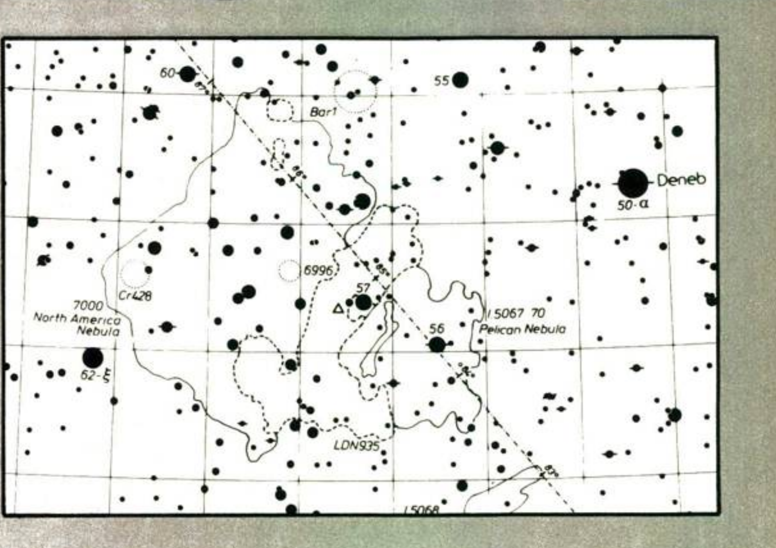
Now you can explore the night sky like never before possible – with this extraordinary new star atlas as your guide. URANOMETRIA 2000.0 Volume 1, The Northern Hemisphere to -6° contains 259 charts that will lead you through the sky from the north pole to the celestial equator. Combined with Volume 2 (available in 1988), this unmatched work will chart 330,000 stars and 10,300 non-stellar objects!

Labeled objects include: stars (to magnitude 9.5), variable stars, multiple stars, star clusters, globular clusters, nebulae, galaxies, quasars, X-ray sources, and more! Whether you wish to explore the heavens with your telescope, with your camera, or simply by roaming this landmark book's charts, URANOMETRIA 2000.0 Volume 1, The Northern Hemisphere to -6° is an unmatched experience in astronomy – for you!

$39.95
#30156

URANOMETRIA 2000.0 Volume 1
The Northern Hemisphere to -6°

- 9″ x 12″, hardbound, 300 + pages
- Locates over 5,000 deep-sky objects
- The entire northern sky at your fingertips!
- Perfect for use with all telescopes
- A super aid for astrophotography


60
55
Bar1
Deneb
50-α
6996
57
Cr428
7000
North America
Nebula
I 5067 70
Pelican Nebula
56
62-ξ
LDN935
I 5068

To order, use the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., 1027 N. Seventh St., Milwaukee, WI 53233. Include for postage and handling: U.S. $1; foreign $1.50. Wisconsin residents add 5% sales tax.

ASTRONOMY

In Focus

Fight the Light!

Sir / A crisis that could cause the death of Palomar Observatory is about to occur: The Calvary Chapel of Costa Mesa in southern California is planning to build a conference center about two miles from the 200-inch Hale telescope. The lighting for this conference center, in addition to the lighting for its football/soccer fields, will dramatically decrease the number of faint stars the Hale telescope can detect.

Robert Brucato, assistant director of the observatory, is lobbying against the conference center from a professional point of view. Amateur astronomers have a chance to accomplish something never before attempted: we can unite under one banner to save the dark skies at Palomar. Light pollution forced Mount Wilson's 100-inch telescope to close last year. Don't let this happen to Palomar.

We need everyone's support for this movement. If your club can donate time to call other clubs, help with mailings, write the San Diego County Board of Supervisors, or help in any other way, contact me at (619) 284-6804 or at the address below.

Thomas King
4160-1/2 32nd Street
San Diego, CA 92104

Revisiting the Boston Tea Party

Sir / The lunar ephemeris programs we ran, based on the astronomical methods of Jean Meeus in *Astronomical Formulae for Calculators* showed that a New Moon fell on December 13, 1773, at 5:14 p.m. local Boston time or 21h58m UT, which differs from the conclusions Sherman W. Schultz reached in "How Dark Was the Night of the Boston Tea Party?" (Forum, August *1987*).

The tea was dumped into Boston Harbor between 6 and 9 p.m. local time, according to historical records. As viewed from Griffin's Wharf, the waxing crescent Moon remained above the southwestern horizon for over three-and-a-half hours after sunset on December 16. At 7 p.m. local time the Moon was at altitude 9° and azimuth 240°. The Moon's age was 3.1 days and the Moon was elongated 43° from the Sun. The illuminated fraction of the Moon was 13 percent, and the horns of the crescent were canted up and to the left — exactly as pictured on the block of stamps!

We talked to William A. Smith, the designer of the stamps, who told us he had consulted an expert who used modern methods to determine the position of the Moon. Mr. Smith also located actual colonial ephemeris tables in 1773 almanacs.

The figures Mr. Smith gave us over the phone agreed with our computer results.

The Moon on the stamp is shown in the correct phase, in the correct part of the sky, at the correct time — the result of careful research by the artist.

Donald W. Olson
and Michael F. Kyle
Department of Physics
Southwest Texas State University
San Marcos, Texas

A Thought Experiment

Sir / Peter Wilson stated that project Daedalus is a "pipe dream inspired by science fiction" and a "foolish expenditure of precious resources" (In Focus, June 1987).

Mr. Wilson misunderstood the concept and purpose of the project. The point is *not* to suggest that this project should ever be put into production. Daedalus is nothing more than a thought experiment designed to promote interest in the more distant aims of space exploration by showing that travel to the stars, though difficult, is not impossible.

To demonstrate that mankind will one day be able to reach the stars, the British Interplanetary Society engaged a group of scientists and engineers to determine how such a star probe could conceivably be undertaken with present day technology or technology that could reasonably be developed from presently available systems. This approach eliminates the science fiction element.

Project Daedalus was intended to remind those of us whose noses are close to the grindstone of reality that it is worth having a dream to aim for, to indicate that it is wrong to dismiss star travel as forever impossible, and to give those of us who will not live to see it happen some idea of what such a star probe might be like. Daedalus is not a prediction or a proposal but a group of best guesses.

In the earlier decades of this century the British Interplanetary Society undertook a similar project, which most people then scoffed at as impossible fiction and a waste of resources: the first landing of men on the Moon. Although the broad outline was different in many details from the eventual reality, they gave a good idea of what such a mission would be like.

Project Daedalus is the next big step, perhaps over a century away and certainly very different from our present concept. The whole thing is a dream, but the time to worry is when serious-minded scientists and engineers lose the ability to have such dreams.

Peter W. Mills
British Interplanetary Society
Chatham, Kent, England

Cloud Pollution

Sir / I enjoy The Backyard Astronomer because it gives me something to look forward to, or as the case more often is in Louisiana, something to wish I'd seen. Here in Louisiana, especially near the Gulf of Mexico, it isn't uncommon to have the sky obscured with clouds for at least half the month. Not to mention mosquitoes big enough to carry off anything that isn't tied down!

That's the problem with living in this part of the country: when most amateur astronomers are griping about light pollution or trying to figure out what type of lens to use, we do a lot of reading in Louisiana. Clear nights with good seeing are rare and require lots of last-minute preparation.

Isaac Davis, Jr.
Lake Charles, Louisiana

Odessa's Not Much of a Crater

Sir / I'm sure you spent many long hours planning and assembling the 1987 Summer Travel Guide; I only hope you checked out other locations better than you verified the meteor crater in Odessa, Texas. Contrary to what you reported, there is no museum, no nature trail, and virtually no crater! Vandals and weathering have practically destroyed all evidence of the event. Only a highly trained eye could discern the remnants of the crater.

The Odessa Public Library has a photographic display dating from the 1950s that is more revealing than a visit to the crater site. Don't feel too bad though, *Texas Parks and Wildlife* made the same mistake in 1980 when it published much the same information you published.

Donna Kelly
Midland, Texas

Space Exploration versus Military Exploitation

Sir / Martin Sickler's "Winning the Battle of the Space Budget" (Forum, August 1987) misses the main reason space exploration is losing popularity: Space exploration has become tainted with military exploitation.

During Reagan's tenure in office hundreds of billions of dollars have been used for arms manufacturing and research on Star Wars technology.

What has the pro-space movement done in response to such squander? It has kept its head down and said it wasn't political or supported Star Wars hoping to benefit from crumbs off the table.

Solar Polar Mission? *Galileo*? *SETI*? *Mars Explorer*? Our nation's economy had the wealth for such projects, but the military-industrial leeches have sucked it dry. Until the pro-space movement realizes its cause is linked to pro-disarmament and, in a large sense, pro-life, we are doomed to be Earth-bound.

Bruce A. Joffe
Piedmont, California

Aromatic Eyepiece Containers

Sir / I've discovered that the plastic container for Crystal Light drink mix makes a good container for 2-inch oculars. The container is about 2-1/2 inches in diameter and 4 inches deep. It also has a replaceable cap.

The only problem is that I get thirsty whenever I observe for more than five minutes — seems the eyepiece smells just a little like fruit punch!

Pat Rochford
Mobile, Alabama

Halley's Faithful Following

Sir / Halley's Comet will receive a better reception in 2061 than Steve Dodson thinks (In Focus, July 1987). As a staff member of the Alexander Brest Planetarium in Jacksonville, Florida, I and seven hundred guests drove for an hour at 3 a.m. to see the comet, and though we saw a spectacular electrical storm instead, many of these people brought guests when we tried to see the comet a week later.

At the second watch thousands of people showed up. The comet was "okay," but nearly everyone enjoyed seeing it. If people not really interested in astronomy were willing to try to see this apparition of the comet even with all the obstacles, why would anyone think the same thing wouldn't happen next time? I would travel as far as necessary — even to the Moon — to see the next apparition.

Kris McCall
Assistant Director
Sudekum Planetarium
Nashville, Tennessee

Oops!

The picture credit for the image of Beta Pictoris on page 22 ("Search for the Primitive" by Richard Berry, June 1987) should have read: Jonathan Gradie and Joan Hayashi (University of Hawaii), Benjamin Zuckerman and Harlans Epps (UCLA), and Robert Howell (University of Wyoming).

Behind the Scenes

The Telescope Owner's Burden

My father built a telescope when I was small. It wasn't a particularly good telescope, but I remember that he showed me some pretty, colored stars through it when I was five or six years old. Time passed. Then, on a boring Saturday afternoon when I was thirteen, I asked Dad what had become of the old telescope.

"It's somewhere in the attic," he said.

We found it behind a mountain of old *Scientific Americans*. Dad and I carried it down to the kitchen. We dusted off the tube and washed the mirror. We rigged a temporary mount for it with my younger brother's stilts and a kitchen stool.

That night I saw Jupiter and Saturn. I already knew everything about the planets — I was that kind of kid — but I'd never seen them in a telescope. My life was changed: I had discovered the stars.

If you are contemplating buying a telescope, I want to give you fair warning based on my own experience: A telescope is a machine that can change your life. One look at Saturn's rings and Jupiter's moons and I was hooked for life. Watch out. It could happen to you.

The world is full of people who have never looked through a telescope. No one has taken the time to show them the craters of the Moon. They have never glimpsed the polar caps of Mars, Jupiter's Great Red Spot, or the Orion Nebula. Their lives remain untouched by the stars.

When you get your telescope, do something for those people: Show them the stars. At first it will be difficult because people are shy about astronomy. Keep at it, though, and before you know it you'll have a crowd in the yard every time you observe with your telescope. And then *you'll* start changing lives.

You may never know which lives you change. A glimpse of Saturn may not "take" right away, and the neighbor kid will walk away unimpressed. But years later, without warning the half-forgotten memory will stir and without quite knowing why the grown-up little boy will buy a telescope and begin to show his friends and neighbors Saturn and the Moon through his telescope.

Sincerely,

Richard Berry

Richard Berry
Editor-in-Chief

If all you want is a low price, any camera or sporting goods store clerk can help you.

But . . . if you need some advice before buying, you may find that they don't know their Maksutov-Cassegrain from a hole in the ground and think that eye relief is a new kind of Visine®. *And* you may have to wait months for your telescope (since fifty expensive cameras take up the same space as a single telescope, some camera stores refuse to keep an inventory of scopes in their high rent New York warehouses -- they'd rather cash your check before they even bother to *order* your scope). *And* you may not get all the parts you expect (scopes have been known to arrive with no-name Kellner eyepieces substituted for name-brand Plossls, 6 x 30mm finders substituted for illuminated 8 x 50mm polar finders, parts missing totally, etc.) *And* you may find that the fine-print freight charges are a lot higher than you expected (as much as $75 in the case of an 8" scope from one New York camera store).

If you want a low price *and* the best advice, then only Ad-Libs Astronomics will do.

We're not a camera or sporting goods store that happens to carry telescopes as a side line. We're a telescope store, pure and simple. We've spent eight years building Ad-Libs Astronomics into one of the country's largest mail order telescope dealers. We've done it by keeping a large inventory of scopes and accessories in stock, giving good discounts, treating our thousands of customers fairly and honestly, *and by knowing what we're talking about.*

Our nearly 50,000 word catalog is the most useful in the industry. The eyepiece section, for example, gives not only the apparent field of view of individual eyepieces, but their eye relief, as well. That's useful information for eyeglass wearers, information we had to measure separately for the 142 different eyepieces we carry, since most manufacturers don't publish those specs. What other telescope dealer goes to that much trouble to be helpful to their customers? What manufacturer, for that matter? Send us a dollar and a stamped self-addressed envelope and we'll send you the 52-page catalog one of our customers said taught him "more about different telescopes and accessories than years of *Astronomy* and *Sky and Telescope*." If you'd prefer, just send us a stamped, self-addressed envelope and we'll send you our free discount price list covering the more than 70 telescopes and 500 accessories we carry, plus some useful information on picking the right telescope.

If you don't know what telescope to buy; if you're not sure how a certain accessory works; if you just want some advice -- call us at (405) 364-0858 and ask. We'll give you an honest, unbiased answer. Can you say the same for your current dealer? As one of our customers wrote us, "I've dealt with a lotta astronomical shops; none have your knowledge nor your honesty."

If you don't need advice, just a low price, call us toll-free at (800) 422-7876 and give us the best price you've found from a dealer who actually has the product in stock. Be sure the price includes freight, since *we ship for free.* We'll do our best to beat any legitimate price. We'll ship fast, giving you every part the manufacturer supplies --with no substitutions, no lies, and no fine print. But don't take our word for it. Ask our customers -- or call the manufacturers to check our reputation. Then call us today.

ad-libs
astronomics

Now in our ninth year of saving you money.

2401 Tee Circle, Suites 105/106, Norman, Oklahoma 73069

Toll-Free Order Line: (800) 422-7876
Use (800) 422-7876 for price quotes and credit card orders only.

Tech Questions/Customer Service: (405) 364-0858
Use (405) 364-0858 for technical advice and all calls from OK, HI, and AK.

Hours: Monday through Friday, 10:00 AM to 5:30 PM CST.
MasterCard, Visa, Discover, American Express accepted.

Freight extra on Canadian, AK, HI, and motor freight orders. $2 service charge on orders under $25. $5 COD charge. U.S. and Canadian sales only.

Meade, Celestron, TeleVue, Bausch & Lomb, Bushnell, Questar, Edmund, Lumicon, University Optics, Olympus, Swarovski, Motofocus, DayStar, Sky Publishing, Vernonscope, Philips, Astromedia, Dover, and more.

NASA Emblems

from ASTRONOMY-Manufactured by the Official NASA Supplier

Wear these historic colorful patches on your jacket or cap, or display them in frames — either way you'll be proud to show them.

SPACE SHUTTLE MISSION

CHALLENGER
BRAND GIBSON McCANDLESS McNAIR STEWART

STS 41B

HART VAN HOFTEN NELSON
CRIPPEN SCOBEE

STS 41C

HARTSFIELD COATS
MULLANE HAWLEY RESNIK WALKER
DISCOVERY

STS 41D

Crippen Sullivan Leestma Ride McBride
Garneau Scully-Power

STS 41G

ALLEN FISHER GARDNER
HAUCK WALKER

STS 51A

MATTINGLY SHRIVER
ONIZUKA BUCHLI
PAYTON

STS 51C

BOBKO WILLIAMS
SEDDON GRIGGS HOFFMAN
WALKER GARN

STS 51D

SPACELAB 3
LIND THAGARD OVERMYER GREGORY THORNTON
VAN DEN BERG WANG

STS 51B

BRANDENSTEIN CREIGHTON NAGEL
FABIAN LUCID
BAUDRY AL-SAUD

STS 51G

SPACELAB 2
FULLERTON BRIDGES MUSGRAVE ENGLAND HENIZE
ACTON BARTOE

STS 51F

ENGLE COVEY LOUNGE FISHER VAN HOFTEN

STS 51I

BOBKO GRABE STEWART HILMERS
PAILES

STS 51J

4″ each, $5.49 each. Set of 12 Space Shuttle — $42.95

NASA
$4.49

GAL
$4.95

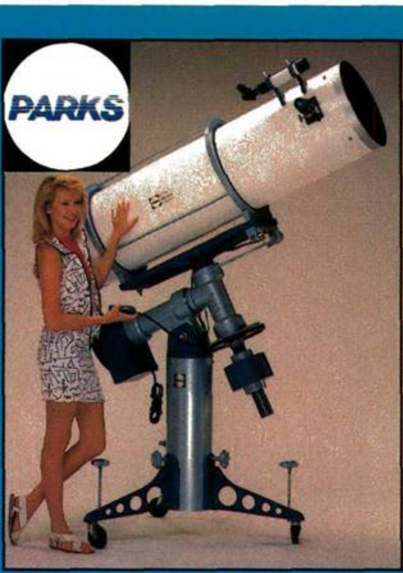
SP2
$5.49

SP3
$5.49

VOY
$4.95

NASA
VOYAGER
Galileo
SPACELAB 2
ASTRONOMY
PHYSICS
BIOLOGY
Spacelab
3
MICROGRAVITY
NASA

To order, specify the patch code or set name on the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., 1027 N. Seventh St., Milwaukee, WI 53233.
Include for postage and handling: U.S. $1; foreign $1.50. Wisconsin residents add 5% sales tax.



OBSERVATORY SERIES - This superbly designed Newtonian features a massive 2½" solid steel threaded shaft. Mount is capable of handling up to 20" telescopes. Precision roller bearings in both axes. Complete with electric right ascension and declination drives w/controls, rotating rings, two 1¼" multi-coated Plossls, giant 8x50 right angle/straight through finderscope, 2" focuser with 1¼" adapter, genuine Parks fiberglass tube with matching aluminum end rings and dust covers. It is the very best available.

Complete 16" Observatory	$12,000	2½" Mount only	$6,500
Complete 14¼" Observatory	$ 8,900	4" Shaft Mount	$25,000 & up
Complete 12½" Observatory	$ 7500	INFO. AVAILABLE UPON REQUEST	
(Shown above)			

SUPERIOR NEWTONIAN SERIES - The Superior series features a 1½" solid steel, threaded shaft mounting with electric right ascension and declination drives, slo-motion controls, rotating rings, two - 1¼" multi-coated Plossl oculars, giant 8x50 right angle/straight through finderscope, 2" focuser with 1¼" adapter, genuine Parks fiberglass tube with matching aluminum end rings and dust covers. Quality components throughout.

12½" f/5 Superior Complete	$3,299
10" f/5 Superior Complete	$2,299
1½" Mount Only Complete	$1,899

SUPERIOR NEWTONIAN SERIES - The Superior series features a 1½" solid steel, threaded shaft mounting with electric right ascension and declination drives, slo-motion controls, rotating rings, two - 1¼" multi-coated Plossl oculars, giant 8x50 right angle/straight through finderscope, 2" focuser with 1¼" adapter, genuine Parks fiberglass tube with matching aluminum end rings and dust covers. Quality components throughout.

8" f/5 Superior Complete	$1,999

6" PRECISION NEWTONIAN - Enter the spectacular world of Newtonians with the economical and quality Precision series. Base unit starts you with a 1" shaft equatorial mount w/declination, slo-motion control and your choice of a 6" f/6, 6" f/8 or an 8" f/6 optical tube assembly. Electric clock drive and declination slo-motion controls (optional). 6" f/6, f/8 and 8" f/6 includes: 1¼" focuser, 6x30 finderscope, 25mm 1¼" ocular, genuine Parks fiberglass tube w/matching aluminum end rings, and dust covers.

6" f/6, f/8 complete	$799	1" Shaft Mount	$399
8" f/6 complete	$999	Elec. Clock Drive w/Slo-Motion Control*	$299

PRT-1 REFRACTOR

Study the cloud bands on Jupiter as well as the majestic rings of Saturn with this 60mm refractor telescope. Utilizes metal tube and quality components throughout. Fully coated 60mm achromatic objective lens provides sharp, crisp images. 700mm focal length. Comes complete with 12.5mm and 6mm .96" ocular, star diag[illegible] 5x24 finderscope, sturdy alt-azimuth mounting, and adjustable wooden tripod. **$149**

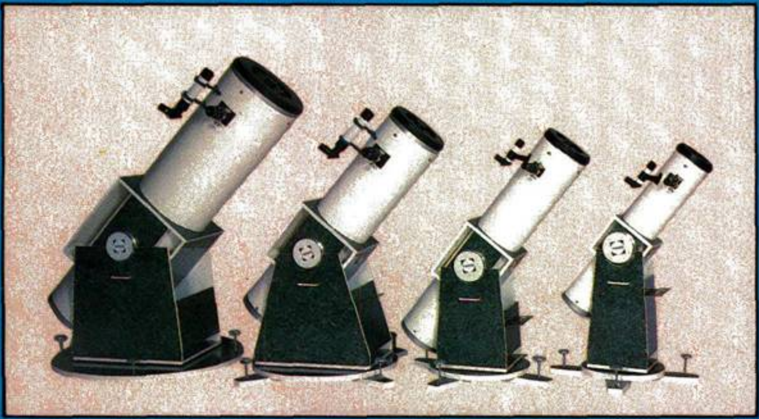
PRT-2 REFRACTOR

Whether for terrestrial [illegible]ical use, the PRT-2 will give you hours of viewing pleasure. 60mm fully coated ac[illegible]ctive lens with 700mm focal length. Extra sturdy metal alt-azimuth mounting has fine [illegible]ion controls in both axes for precise centering and tracking of objects of interest. Com[illegible] 6mm (117x) and 20mm (35x) ocular, star diagonal, 2X barlow, accessory tray, built-in [illegible] and adjustable wooden tripod.

$199

PRT-46 REFRACTOR

May be the best 60mm refracting telescope available in its class. Brilliant images. 910mm focal length, 60mm fully coated achromatic objective lens. Equatorial mount with right ascension and declination slow-motion controls. Complete with 4mm, 9mm, and 22mm oculars, star diagonal, erecting prism, solar projection screen, 2X barlow, built-in 10X finder, moon filter, heavy duty adjustable wooden tripod and illuminated accessory tray. **$349**



TRAVEL THE UNIVERSE FIRST CLASS . . . AT AN ECONOMY FARE!

Introducing the all new

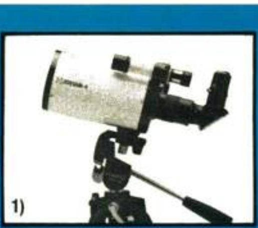
PARKS DOBSONIAN REFLECTORS!!

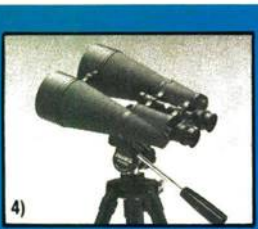
Designed and engineered to be the very best performing alt-azimuth Newtonian telescope on the market today. Available in 6", 8", 10" and 12½" sizes: each unit utilizes Parks fiberglass tubes, fine annealed, full thickness pyrex optics and quality components throughout. The mountings are manufactured from thick industrial grade particle board and are covered with a durable marble design laminate. All edges are finished with a decorative PVC banding. Base and leg supports are edged with a protective vinyl bumper. Mount is designed to dampen vibration quickly and efficiently. Tube mount is hinged to allow easy mounting and rotation of the tube. All telescopes and mounts include: wheels, leveling screws, *accessory tray* and carrying handles.

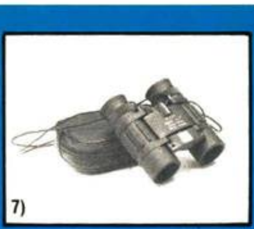
6" f/6, f/8 and 8" f/6 includes: 25mm 1¼" ocular, 6x30 right angle finderscope, 1¼" focuser and dust covers.

10" and 12½" f/5 includes: 25mm 1¼" ocular, giant 8x50 right angle/straight through finderscope, 2" focuser with 1¼" adapter and dust covers.

COMPLETE UNITS:		MOUNTS ONLY	
6" f/6, f/8	$499	6"	$219
8" f/6	$649	8"	$249
10" f/5	$999	10"	$299
12½" f/5	$1,299	12½"	$349


1)


4)


7)

2)

5)

8)

3)

6)

9)

1). **JOVIAN-4.** Enjoy the compactness, portability and quality of this 4-inch Schmidt-Cassegrain. Superior optics provide bright color corrected images that are crisp to the edge of the field. Complete with unique built in camera adapter, 5x24 finder, 25mm 1¼" Plossl, lens cover, carrying case w/shoulder strap, and 1¼" diagonal prism. **$399**

2). **EYEPIECES.** Parks offers a complete line of Kellner, Orthoscopic, Plossl, and Erfle oculars. All professional high quality optics in precision machined brass and aluminum housings. Threaded barrels accept all popular filters. Multi-coated for excellent light transmission and image contrast. See below for pricing.

3). **COLOR FILTERS.** Increase contrast and resolution of lunar and planetary detail with 1¼" photo visual color filters. Made of the finest quality Hoya glass with 26mm of clear aperture. Threaded on both ends to allow stacking. **Each $10**
Polarizer $15

4). **GIANT BINOCULARS.** Quality giant 80mm objective lens. Advanced ZCF design with central support bridge. Fully coated for maximum image contrast. Includes lens shades, straps, deluxe carrying case and photo-tripod adaptor. **$179**

5). **WIDE FIELD 60.** Maximum resolution and long eye relief. 60mm fully coated air spaced objective lens. 420mm focal length with 28mm 1¼" ocular provides ultra wide 3 degree field of view. Includes star diagonal and 6 x 30 finder. Mounts on any standard photo-tripod. **$179**

6). **ZOOMSCOPE 60.** 60mm coated objective lens. Metal construction zooms from 15X to 60X power. Mounts easily on any standard photo-tripod. Excellent terrestrial telescope. **$99**

7). **COMPACT BINOCULARS.** Widest field available. Light weight, multi-coated roof prism. Black rubber for shock resistance. Complete w/straps and case.
8 x 25, 8.7° $59
10 x 25, 7° $67

8). **SUPER SPOTTER.** Versatility at its best! 60mm fully coated objective lens. Rotatable head allows you to select 20X or 50X magnification. Utilizes 4 element Orthoscopic eyepieces. Straight through or right angle viewing. Great for astronomy, nature hikes, whale watching, firing ranges, and much more. **$169**

9). **COMPANION.** Compact and lightweight. 9X to 30X zoom spotting scope. 40mm coated objective lens. Mini table top tripod included. **$49**

Kellner Oculars

6, 12, 25 or 40mm 1¼"	$25.00
50 or 60mm 2"	$49.00

Orthoscopic Oculars

6, 12.5 or 25mm 1¼"	39.00

Plossl Oculars

6, 9, 12.5, 18, 25 or 40mm 1¼"	49.00
50mm 2"	69.00

Erfle Oculars

20 or 32mm 1¼"	49.00
32mm 2"	79.00

Barlow Lenses

2x Barlow Lenses 1¼"	29.00
2x Barlow Lenses 2"	69.00

Visual Accessories

Star Diagonal 1¼"	39.00
Hybrid Star Diagonal	29.00
Porro Prism 96"	39.00
Porro Prism 1¼"	49.00

Camera Adapters

Camera Adapter 96"	29.00
Camera Adapter 1¼"	29.00
Camera Adapter 2"	29.00
Super Spotter	19.00
Parks Wide-Field 60	19.00

T-Rings

Pentax 'S', Pentax 'K' Nikon, Minolta, Canon, or Olympus T-Ring	9.00

Guidescopes

60mm x 700mm f/l Refractor Guidescope	129.00
60mm Mounting Brackets per pair	20.00

Finderscopes

6x30 7° field	33.00
Rt. angle, 7° field	37.00
6x30 Finderbracket	8.00
Deluxe 8x50	39.00
(Can be used straight through or rt. angle, removable 1¼" ocular 4¼ degree field)	
8x50" Mounting Brackets	15.00 pr.

Elliptical Secondary Mirrors

1.33" Elliptical Mirror	25.00
1.55" Elliptical Mirror	29.00
1.83" Elliptical Mirror	35.00
2.14" Elliptical Mirror	41.00
2.60" Elliptical Mirror	50.00
3.10" Elliptical Mirror	75.00

Focusers

1¼" Focuser	39.00
2" Focuser (w/1¼" adapter)	59.00

Primary Mirror Cells

6" Mirror Cell	29.00
8" Mirror Cell	39.00
10" Mirror Cell	49.00
12½" Mirror Cell	69.00

Spider/Diagonal Holders

Spider 7" I.D. Tube	14.00
Spider 9⅜" I.D. Tube	15.00
Spider 11⅞" I.D. Tube	16.00
15⅞" I.D. Tube	19.00
1.33" Diagonal Holder	12.00
1.55" Diagonal Holder	13.00
1.83" Diagonal Holder	14.00
2.14" Diagonal Holder	16.00
2.60" Diagonal Holder	20.00
3.10" Diagonal Holder	25.00

Setting Circles

6" Engraved Alum. Setting Circles 1" Bore	39.00
6" Engraved Alum. Setting Circles 1½" Bore	39.00

Mounting Rings

Clamp Rings for 7" Tube	50.00
Clamp Rings for 9⅜" Tube	60.00
Clamp Rings for 11⅞" Tube	70.00
Rotating Rings for 9⅜" Tube	195.00
Rotating Rings for 11⅞" Tube	295.00
Rotating Rings for 15⅞" Tube	395.00
Rotating Rings for 18" Tube	495.00

Light Pollution Blocking Filter

LPB Filter 1¼"	59.00
LPB Filter 2"	69.00

Photo Visual Color Filters

1A, 8, 11, 12, 15, 21, 23A, 25, 29, 38A, 47 56, 58A, 80A, 82A, ND13 ND25, ND50.	10.00
Polarizing Filter	15.00

Fiberglass Tubes & End Rings

For 4½" Mirror	
5" x 48"	39.00
For 6" Mirror	
7" I.D. x 31" to 52"	52.00
7" I.D. x 53" to 60"	56.00
Alum End Rings per pair	20.00
For 8" Mirror	
9⅜" I.D.x24" to 37"	56.00
9⅜" I.D.x38" to 55"	68.00
9⅜" I.D.x56" to 60"	72.00
9⅜" I.D. x 61" to 75"	80.00
Alum. End Rings per pair	25.00
For 10" Mirror	
11⅞" I.D.x40" to 48"	99.00
11⅞" I.D.x49" to 62"	116.00
11⅞" I.D.x63" to 72"	132.00
Alum. End Rings per pair	34.00
For 12½" or 14¼" Mirror	
15⅞" I.D.x48" to 59"	148.00
15⅞" I.D.x60" to 69"	160.00
15⅞" I.D.x70" to 79"	170.00
15⅞" I.D.x80" to 100"	190.00
Alum. End Rings per pair	40.00
For 16" Mirror	
18" I.D.x48" to 60"	160.00
18" I.D.x61" to 90"	240.00
18" I.D.x91" to 120"	280.00

Parabolic Primary Mirrors

6" f/6, f/8 Mirror	99.00
8" f/6 Mirror	159.00
10" f/5 Mirror	299.00
12½" f/5 Mirror	499.00

Photographic Tripods

Tripod (spring loaded)	99.00
Deluxe Tripod (fluid head)	175.00
Table Top w/Micro Adj.	49.00
Mini Table Top Tripod	19.00
Slow-Motion Control to fit Photo-Tripod	39.00

7x35 WIDE FIELD. Whether at a sporting event or gazing at the Milky Way, the Parks 7x35 ultra wide-field binoculars will provide excellent viewing with an incredible 12½° field. Fully coated, heavy-duty construction, yet compact. Complete with lens cap, straps and case. **$69**

ILLUMINATED RETICLE. New state-of-the-art cordless design featuring rheostatic brightness control and on/off switch. Top quality 1¼" 12.5mm multi-coated Orthoscopic w/fully focusable dual crosshair for precision guiding. **$79**

OBSERVING CHAIR. View in comfort. Sturdy, yet light weight. Fully adjustable height. Thick padded upholstered seat. Chrome-plated tripod legs fold up for extreme compactness and portability. **$47**

TELESCOPE DUST COVERS. Now available for 6", 8", 10" and 12½"/14" telescopes. Manufactured from durable ABS Plastic. Each cover is felt lined for a tight fit. Additional felt is included for fitting of various tube sizes.
For 6" telescope . **$10 ea.** For 10" telescope **$15 ea.**
For 8"telescope . . **$12 ea.** 12½/14" telescope **$20 ea.**

PARKS OPTICAL

270 Easy St.
Simi Valley, California 93065
Information . . . . (805) 522-6722
Order only in CA. 1-800-43-PARKS
Order only National 1-800-44-PARKS

All Parks products come with 100% satisfaction guarantee or return in original condition for a full refund, less shipping within 30 days of receipt. 10" or larger telescopes, mountings, and tubes over 9⅜" are shipped freight collect. All other merchandise add 3% in continental USA to cover shipping and handling. (Minimum $4). Air freight and shipping worldwide, information upon request. FREE COLOR CATALOG. (foreign USD $5). Parks Optical is not open to the public. Merchandise available through mail order or at any authorized Parks dealer worldwide. Most of listed products in this ad are offered at very special prices. Suggested retail price is higher.

ASTRONOMY
Reviews

Hassle-Free Astrophotography

Precision Sidereal-Rate Clock Drive Kit, (Astro Kits, 824 Bronx River Road, Bronxville, NY 10708), kit, $99; assembled, $124.

Have you ever thought how nice it would be to take sky pictures without having to constantly tend the camera or tie up your main telescope? Well, Astro Kits has come up with a gadget that makes this possible and does the job quite well.

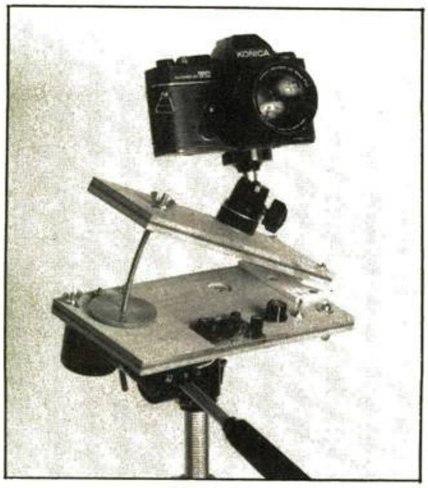
The basic idea has been around for years. Astro Kits has added enough refinements so anyone can run a night's worth of perfectly tracked five- to thirty-minute exposures with a wide-angle or standard camera lens or even a 200mm telephoto lens. All you do is aim the camera at the celestial pole and start each new exposure. I like it because I can shoot a nice set of constellation slides while I'm observing with my big Dobsonian telescope.

The unit I tested came already assembled, so I can't vouch for the kit version of the camera drive, but the assembly instructions were written in a clear and straightforward fashion. I saw nothing I couldn't have done with ordinary household tools and a soldering iron.

The camera drive consists of two boards, a plastic hinge, a 6-inch-long "drive gear" rod and brass gear, a small DC motor with a meshing gear, a ball-swivel camera mount, the components for a constant voltage power supply, and a battery holder. The components are mounted on the lower board, and the camera on the swivel is attached to the upper board. The unit is made to be mounted on a standard camera tripod. Astro Kits gives a twenty-four-hour help line to call if you have a problem assembling the kit.

I tested the drive's performance under both benign and hostile test conditions. For the benign tests I used fresh batteries, aligned the polar axis carefully, adjusted the drive speed to exactly the right rate, and made exposures up to fifteen minutes with 28mm, 50mm, and 135mm lenses. For the hostile tests I installed a set of four half-dead AA cells on a winter night with temperatures well below 0° F, didn't bother with careful polar alignment, didn't bother to set the drive rate, and made test exposures with an out-of-balance 400mm telephoto lens.

Left: The Milky Way in Sagittarius-Scorpius. Photo by Jeff Kanipe, who used the Astro Kit camera drive (below).



As promised, the photos taken in the benign tests were beautifully tracked. The first few taken in the hostile test were pretty good: they showed only short star trails even though I was using a lens with twice the maximum recommended focal length and hadn't adjusted the drive rate or lined up carefully on the pole. Later photos on the roll showed progressive low-temperature battery failure. For a fair test I would have used fresh alkaline batteries or the plug-in extension cord Astro Kits supplies with the unit and put the battery pack into my pocket for warmth. I could have also used power from a car battery but didn't because the test was intended to be a worst case.

I couldn't have done better if I had guided the benign test photos by hand and probably would have done worse because I'd have gone cross-eyed guiding three or four hours worth of timed exposures. As it was I had a pleasant evening's observing and a nice batch of pictures to show for it.

The Astro Kits camera drive uses what telescope makers call a bent bolt drive system. A 5-1/2-inch length of #10-32 brass threaded rod is curved to a radius of 7.14 inches and works like a 14.28-inch-diameter gear with 1,436 teeth. Each time an internally threaded gear running on the bent bolt turns once, the gear/bolt is advanced by 1 sidereal minute. By adjusting the rate of a small DC motor to turn the threaded gear once every 60 seconds, we obtain a precise sidereal-rate drive.

A problem common to all battery-powered mechanical devices is maintaining a constant speed under varying voltage and load. The Astro Kits camera drive relies on a two-stage voltage regulator to supply a constant voltage to the drive motor and the extremely high ratio of the drive train to make the load nearly constant. Before an evening's use, it's a good idea to carefully "rate" the motor against the sweep hand of your watch so the threaded gear turns exactly once per minute.

Astro Kits claims that the present model of the drive can handle lenses with focal lengths up to 210mm. Based on the excellent results with the 135mm lens and the promising but not quite usable results with the 400mm and dead batteries, I'd consider this claim realistic or even a bit conservative. The company suggests that a heavy-duty metal hinge allows the drive to handle lenses up to a 500mm focal length.

Astro Kits plans to release a more sophisticated kit with a stepper motor drive later this year. Because a stepper motor's rate does not depend on its load, the improved drive should be more reliable than the DC motor drive, though somewhat more expensive.

Overall I was pleased with the product. Dyed-in-the-wool do-it-yourselfers might snort at paying $124 for something they could build equally well on the third or fourth try. With the benign and hostile tests I found that the device works well but is not idiot-proof. The bottom line? I was happy with the good pictures I got on the first try. — *Richard Berry.*

New PBS Science Series Rings True

The Ring of Truth, PBS science series hosted by Philip Morrison, (Public Broadcasting Associates, Inc., major funding by the Polaroid Corp., 1987), premieres October 20.

How does science know what it knows? We often assume that theories, facts, and observations collaborate in some way to reveal the universe to us. But how is this done exactly? What are dependable, scientific perceptions based upon?

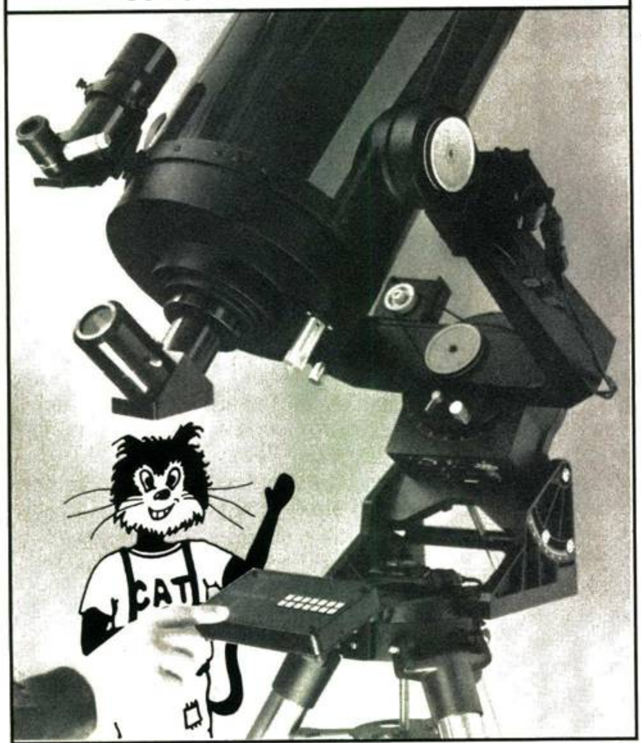
This is the theme of a new six-part science series, *the Ring of Truth*, to be aired this month on most PBS stations. Hosted by Massachusetts Institute of Technology physics professor and *Scientific American* book review editor Philip Morrison, the series proposes to explain "how science works" from observation of a phenomenon to its measurement and interpretation.

Morrison is an enthusiastic host whose outgoing demeanor reminds me of a sophisticated "Mr. Wizard." He manages to be didactic without being dogmatic, concise without being superficial. Undoubtedly the same material could have been presented by any scientist, but Morrison's effusive personality arouses the viewer, even one with only a casual interest in science.

The series begins with "Looking," a discussion of how science perceives the universe through instruments and how those instruments influence our world. Morrison takes us back to Renaissance Italy where we consider the impact of the telescope. Galileo saw the Moon as a place rather than as an abstract element of heaven. By closing the gap between the heavens and Earth, Galileo outraged the religious tyrants of the period, but he also opened a window to the universe that astronomers still look through. Instruments, Morrison concludes, are the tools of the builders of science that stimulate newer instruments and further discovery.

In the next episode, "Change," Morrison demonstrates that matter and energy are equivalent. We observe the voracious appetites of cyclists participating in the 2,000-mile *Tour de France* bicycle race and tote up the

THE CAT ON A MEADE 10'' SCT



Advanced Technology Instruments
P.O. Box 246
Carmel Valley, CA 93924
(408) 659-0437

SEE 100 GALAXIES PER HOUR!!!

Is that possible? With the CAT it's easy! The CAT is the Computer Aided Telescope accessory that attaches to most commercial telescopes in minutes with simple hand tools. It's compact, consumes less than 10 watts, and uses precision optical encoders to monitor RA and DEC with more than 25 times the resolution of most setting circles.

The CAT will help you polar align quickly and accurately. Finding objects takes only seconds with the RED CROSS pointing guide. Want to see M22? Just press **M22 ENTER.** The object identity, type, size, brightness, visual quality, and more are displayed on large, night-vision red displays. To center M22, just move your scope until the RED CROSS elements converge, and observe. It's so easy!

You can also tell the CAT to select objects for you! Just enter the characteristics of the objects you want to see, such as type, brightness, size, visual quality, minimum altitude. The CAT will find objects that satisfy these criteria, describe them, and guide you to them.

Want to know what's in the field? The CAT will identify the deep-sky object nearest the center of the field and display the total number in the field, **even as you move your scope!** Perfect for comet hunting!

The CAT contains more than 8000 astronomical objects, including the 250 brightest stars, 100 interesting double stars, the famous Messier Catalog of 110 deep-sky wonders, and the new deep-sky observer's standard — the 7840 entry **CNGC.**

Brackets for mounting the precision optical encoders to C8, C11, C14, M8, M10, and other commercial telescopes are available. An RS-232 option can be ordered to interface the CAT to computers and printers. It is usually straightforward to adapt the CAT to custom instruments. Send $5 for an informative 80-page User's Manual.

IMPORTANT: The suggested retail price is scheduled to increase from $1495 to $1995 on Dec. 1, 1987. Order now and **save.**

incredible amount of food they take in (two to three times the norm) versus their energy expenditure. Morrison compares the cyclists' intake to "jelly doughnut units," in which one jelly doughnut equals 250 calories. The racers use up approximately thirty-two jelly doughnut units' worth of energy a day, most of which is released as body heat. According to the principle of mass-energy conservation, the same amount of energy would be released, though more suddenly, in a bonfire of thirty-two jelly doughnuts. To prove the point, Morrison ignites such a pastry pyre in a backyard barbecue pit.

In the third episode, "Mapping," Morrison takes us to the hinterlands of Nebraska and Kansas to determine Earth's circumference by noting the differences between Antares' height at these two latitudes. Morrison also shows us that with a pendulum clock and sidereal time we can determine our longitude on Earth. These were techniques used by mapmakers of the past to chart the world before the days of satellite photography. Morrison emphasizes that charting any unknown territory is the first step toward discovery and as such is a "parable for the growth of understanding in many branches of science."

"Clues," the fourth episode, illustrates how reconstructing the past with evidence of the present is a major factor in how science works. One of the most interesting segments of the entire series is a look over the shoulders of geologists drilling deep into the floor of the Mediterranean Sea. We discover something astonishing in the sand, gravel, and clam fossils that spill from the scientist's pipewash: 5 million to 6 million years ago the Mediterranean dried up and became a desert. The discovery tells us that the Earth is a dynamic place still capable of considerable geologic change.

The final two episodes, "Atoms" and "Doubt," are not as fundamental as the previous programs. "Atoms" delves into quantum theory, and Morrison wastes no time in introducing diffraction gratings and the properties and various energy states of atoms. The segments that show a chef who divides his pasta into thousands of thin strands and Julia Child, who purposely burns a meal for science's sake, keep this episode from bogging down.

The final episode goes into even more detail about atoms and energy states. Morrison discusses how stellar spectra have been used to deduce the composition of stars and galaxies. Up until several years ago astronomers were confident that the universe was composed of 90 percent hydrogen. However, recent spectroscopic research has cast doubt on this finding. Judging from the unaccountable masses of galaxies, the universe seems to be composed of matter we cannot see, something unknown. Morrison wonders if our eyes and instruments have been playing tricks on us. Obviously there is a lot of universe out there yet to be discovered.

The Ring of Truth is an engaging, eye-opening series with plenty of appeal for the layman. However, even though it sometimes ventures into technical areas, I recommend the program to people who may have had negative experiences with science. The series offers those viewers the chance to rediscover how exciting and meaningful scientific pursuit can be. *— Jeff Kanipe*.

Life and Death in Space

Pioneering Space by James E. and Alcestis R. Oberg, (McGraw-Hill, 1986), ISBN 0-07-048034-6, hardcover, 298 pages, $16.95.

Most science books, even those meant for the layman, suffer from one or more common drawbacks. Sometimes the books are too elementary, full of basic information that would insult a modern schoolchild; other times these supposedly popular-level books may require the reader to possess a thorough knowledge of physics and math. They can also be out of date, especially those addressing space and astronomy, where our knowledge can be revolutionized within the few minutes it takes a spacecraft to zoom past a planet or a moon.

Fortunately *Pioneering Space* has none of these problems. Overall it is a refreshing, entertaining, and thought-provoking look at the practical problems of living in space. The authors, the husband and wife team of James and Alcestis Oberg, demonstrate there are countless space stories and episodes that have yet to be discovered by the popular press. The book is filled with these stories — some ghoulish or scary, others uplifting or funny. Yet no matter how they strike you, these stories reflect what life is like in space. Such accounts clearly illustrate that space exploration is an exciting endeavor, one that must deal with human problems as well as the dangers of venturing beyond Earth.

For example, there's the story of how one space-walking Soviet cosmonaut saved the life of a crewman by grabbing the crewman as he drifted out the open hatch of their craft. Somehow the second cosmonaut, who was unattached to any kind of umbilical cable, had unintentionally drifted through the portal into space.

In another section the Obergs speculate about the deaths that might result from catastrophes in space. Despite the common misconception that the human body would explode if suddenly placed in the vacuum of space, they point out that a sort of mummification would result after a relatively quick and perhaps painless death. Slower, more horrible deaths would result from a severe surge of radiation from a solar flare or an increase of carbon dioxide inside a spacecraft.

And yes, the topic of bathrooms in space is discussed in detail. We read about the infamous plastic bags, which one astronaut refused to use for an entire eleven-day flight, and the cantankerous unisex space toilet on the shuttle. It's all here.

Pioneering Space takes a look at spaceflight experienced aboard *Skylab*, the shuttle, *Salyut*, and other earlier manned spacecraft. The authors use information from diaries kept by space travelers, especially Soviet cosmonauts, who, the Obergs point out, have been much more forthcoming in their thoughts and feelings about spaceflight than the American astronauts.

This book is more than a series of space anecdotes, however. There are extensive discussions of how extended spaceflight affects men and women, both psychologically and physiologically. Readers will also find excellent descriptions of the planning that goes into providing a breathable atmosphere inside spacecraft and the possibilities of developing a closed system to provide a constant source of food and water from recycled wastes.

Pioneering Space should be a welcome addition to the library of anyone interested in the challenge of living and working in space. *—Ray Grasshoff*.

Archaeoastronomy

Stonehenge Complete by Christopher Chippindale, (Cornell University Press, 1987), ISBN 0-8014-9451-6, paperback, 296 pages, $24.95.

The "Giants' Round" moved from Ireland by Merlin's magic, the ancient temple of the Druids, the astronomical observatory, and the monument of a people physically and spiritually in tune with the universe — each age has defined Stonehenge its own way. Chippindale provides a chapter of Stonehenge facts at the beginning and one at the end of the book, which show how little we know and how much we don't.

We know Stonehenge was built in four stages, beginning in 3100 B.C., and that the stones were moved to England from Wales. The rest of the book is a chronological look at what Stonehenge has meant to each age, highlighted by paintings and drawings of each time period. Through this collection of explanations of Stonehenge

ASTROPHOTOGRAPHY

A Step-By-Step Approach

Robert T. Little
Foreword by Isaac Asimov

"For the amateur wanting to know what astrophotography is all about and what can be done with only modest equipment, Little's *Astrophotography* should fill the bill. This heavily illustrated book can be read in a few hours, and it will give the reader a good feel for the scope of astrophotography from the tripod-mounted camera to prime-focus, deep-sky, and high-power projection photography. For each level of endeavor, the author points out the objects and events best suited along with pictorial examples of each. Subjects ranging from constellations to planetary close-ups and distant galaxies are presented, together with handy lists of numbered steps for photographing them."
—*Sky and Telescope*

1986 • 79 pp • 50 photos • 0-02-948980-6 • $19.95

To place a VISA or MasterCard order,
call toll-free 1-800-257-5755
(In NJ, AK, or HI dial direct 1-609-461-6500)
or order from
Macmillan Publishing Company
866 Third Ave., New York, NY 10022 • Att: D. Decker

Prices are good in U.S. only and subject to change w/o notice.

Historical Contributions
from Harvard University Press

Darkness at Night
A Riddle of the Universe
Edward Harrison

Why is the sky dark at night? In this richly illustrated book, Edward Harrison (author of *Masks of the Universe*) eloquently describes the misleading trails of inquiry and strange ideas that have abounded in studying the enigma of a dark sky.

$25.00

The Physicists
The History of a Scientific Community
in Modern America
Daniels J. Kevles

"[An] uncommonly good book ... with a sharp eye for the telling anecdote."
—John Leonard, *New York Times*

$12.95 paper

79 Garden St., Cambridge, MA 02138

NOTHING UP OUR SLEEVE

Low Prices and Great Service on Meade Telescopes and Accessories from a dealer you can trust.

- **Free Shipping**
- **Orders out Same Day**

CALL NOW: 1-800-222-8252
MO: 1-800-223-8252

LX-5 SCANNER

2080LX5	**$1779**
2120LX5	**$2599**

MTS MODULAR Schmidt Cassegrain

SC8	**$799**
SC10	**$1399**

MTS MODULAR Schmidt Newtonian

SN6	**$579**
SN8	**$799**

4" S.C. PORTABLE Schmidt Cassegrain

2045	**$579**
2045LX-3	**$749**

3.1" PLANETARY High Contrast

310 ALTZ	**$449**
320 Eq. Mt.	**$599**

LX-5 Acc.

#39 Decl	**$99**
#1200 Electric Focuser	**$149**
Tri/W Bag	**$89**
Piggy Mt	**$35**
Color Filters	**$79(6)**
O.A. Guiders	**$169**
Ctr. Wt. Sys.	**$99**

MTS S.C. Acc.

MCOG 8"	**$89**
MCOG 10"	**$119**
#788 Drive	**$139**
780 LX-3 Dr.	**$439**
66A, 38M	**$139**
Setting Cir.	**$39**
#43 Decl.	**$89**
#62 T.A.	**$39**

MTS S.N. Acc.

MCOG 8"	**$89**
MCOG 6"	**$69**
6x30 VF	**$49**
8x50 VF	**$79**
8x50 PVF	**$139**
1¼ T.A.	**$39**
V.P. T.A.	**$59**

Drive — See S.C.

2045 Acc.

Tri./W.	**$259**
#928 Erect Prism	**$59**
36 Dr. Cor.	**$99**
38A Decl.	**$99**
Dew Cap	**$59**
#62 T.A.	**$39**

Other Meade Scopes

6600-6"	**$599**
97E2-3.5"	**$349**
Pathfinder 15X-60X	**$279**
#226-60mm	**$149**

MEADE SERIES 4000

Super Plossl-52° AF, 5 El.
6.4, 9.7, 12.4, 15, 20, 26 .... **$89**
32, 40 .... **$114** 56-2" **$189**
#140-2X, #142-2.8X **$79**

SUPERWIDE
67° AF, 6 El.
13.8-**$139** 18-**$159**
24.5-**$169**
2"-32-**$239** 2"-40-**$309**

ULTRAWIDE
84° AF, 8 El.
4.7-**$169** 6.7-**$199**
8.8-1¼/2"-**$239**
14-1¼/2"-**$279**

CREVE COEUR
Camera & Video
700 N. New Ballas • St. Louis, MO 63141 • (314) 567-3456

30 DAY MONEY BACK GUARANTEE:
NO MAIL ORDER "SLICK TRICKS"! We guarantee your satisfaction or we'll refund your money (less shipping).

MC
VISA
DISCOVER

— some excessively imaginative, some scientifically possible — we are left with the conclusion that Stonehenge has yet to be explained. And maybe it never will be, maybe every age "has the Stonehenge it deserves — and desires." — *K.R.M.*

Astrophysics

Astrochemistry: Proceedings of the 120th Symposium of the International Astronomical Union, India, 1985, edited by M. S. Vardya and S. P. Tarafdar, (D. Reidel, 1987), ISBN 90-277-2359-1, hardcover, 613 pages, $106.

Calibration of Fundamental Stellar Quantities: Proceedings of the 111th Symposium of the International Astronomical Union, Italy, 1984, edited by D. S. Hayes, L. E. Pasinetti, and A. G. Davis Philip, (D. Reidel, 1985), ISBN 90-277-2109-2, hardcover, 644 pages, no price given.

Biography and History

James Lick's Monument by Helen Wright, (Cambridge University Press, 1987), ISBN 0-521-32105-0, hardcover, 231 pages, $32.50.

A quarter of the way through *James Lick's Monument*, James Lick, the reclusive San Francisco millionaire who wanted to build the world's largest telescope, is dead. The book's focus shifts to Captain Richard Floyd, the sea captain and former Confederate naval officer responsible for bringing Lick Observatory into existence.

From Lick's death in 1876 to the completion of the observatory in 1888, Floyd supervised every aspect of the observatory's design and construction. As president of the Lick trust, Floyd toured Europe seeking advice on telescope designs from leading astronomers, negotiated with telescope makers, and supervised construction on Mount Hamilton.

Floyd's twelve-year ordeal is painstakingly documented by Helen Wright. But the inundation of historical detail does not obscure the impressiveness of Floyd's achievement or the charm of his era. To watch as a wealthy California pioneer and an itinerant sea captain build the world's premier astronomical facility is a fascinating tale. — *S.C.*

Niels Bohr: A Centenary Volume, edited by A. P. French and P. J. Kennedy, (Harvard University Press, 1985), ISBN 0-674-62416-5, paperback, 403 pages, $14.95.

Niels Bohr: His Life and Work as Seen by His Friends and Colleagues, edited by S. Rozental, (North-Holland Physics Publishing, 1985), ISBN 0-444-86977-8, paperback, 355 pages, $24.95.

General Interest

The Concise Handbook of Astronomy by Ian Ridpath, (Gallery Books, 1986), ISBN 0-8317-1766-1, hardcover, 96 pages, $7.98.

To give a nonastronomer friend an overview of the field of astronomy, *The Concise Handbook of Astronomy* can be served as an appetizer that both takes the edge off his hunger and prepares his palate for more.

Ridpath's introduction to astronomy concisely presents the major topics — telescope types, the planets, comets, meteors, stars, supernovae, black holes, galaxies, cosmology, and future telescopes. A reader who has been intrigued by these factual nuggets and lavish photographs is given a good stepping stone for exploring astronomy in more detail through other sources. — *K.R.M.*

Editorial Position Available at ASTRONOMY

We seek a technical editor/writer with a firm understanding of and broad experience with telescopes and other astronomical equipment, photography and photographic equipment, and observational astronomy.

The qualified candidate will be well grounded in basic astronomy and thoroughly conversant with the modern science of astronomy and must demonstrate the ability to make the technical side of the hobby and scientific astronomy understandable to an audience of astronomy enthusiasts, armchair astronomers, and amateur astronomers. He or she will be able to write effectively about astronomy from scratch, evaluate manuscripts for content and technical accuracy, and edit stories written by astronomers and freelance writers.

Employment requires relocation to Milwaukee.

Kalmbach Publishing Company offers a full benefit program including major medical, hospitalization, dental, and life insurance. Kalmbach is an equal opportunity employer.

Send your resume, samples of your writing, names of three references, and minimum salary requirements to:

Richard Berry
Editor-in-Chief, ASTRONOMY
1027 North Seventh Street
Milwaukee, WI 53233

PUZZLED WHEN CHOOSING OPTICAL EQUIPMENT?

Let the trained professionals at Scope City help you make the choice that's best for you.

Scope City

VISIT THE WORLD'S LARGEST AND MOST COMPLETE TELESCOPE & BINOCULAR DISCOUNT CENTERS. NOW FOUR LOCATIONS TO SERVE YOU!

MAIL ORDER
Call for the most competitive prices
P.O. Box 440
Simi Valley, CA 93065
Information: (805) 522-6701

MAIN OFFICE
679 Easy St.
Simi Valley, CA 93065
(805) 522-6646

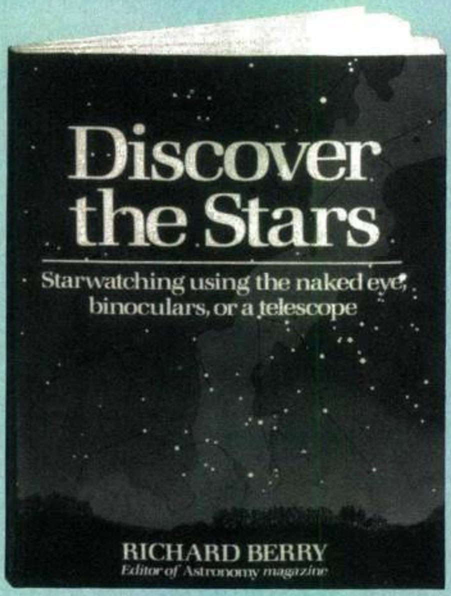
Showroom:
SAN DIEGO, CA
4766 Clairemont Mesa Blvd.
805 Fwy. to Clairemont
Mesa Blvd. exit, West.)
(619) 277-6686

Showroom:
COSTA MESA, CA
3033 S. Bristol
(405 Fwy, to
Bristol exit, 2 blks
South)
(714) 957-6900

Showroom:
TORRANCE, CA
3132 Pacific Coast Hwy
(405 Fwy, to
Crenshaw exit South,
West of Pac. Coast Hwy
3 blks)
(213) 326-3251

Showroom:
SIMI VALLEY
679 Easy St.
(118 Fwy to First
St. exit, South
½ mile, right on
Easy St., 2 blks)
(805) 522-6646

ASTRONOMY's Richard Berry presents a very special guide for stargazing . . .


Discover the Stars
Starwatching using the naked eye, binoculars, or a telescope
RICHARD BERRY
Editor of Astronomy magazine

DISCOVER THE STARS

DISCOVER THE STARS is a unique stargazer's guidebook. In 120 pages, this book will teach you the stars and constellations, introduce you to deep sky objects, and help you find your way around the moon and planets. Whether you're interested in stargazing with the naked eye, binoculars, or a telescope, DISCOVER THE STARS is the perfect companion. From the first section of 12 two-color maps, each accompanied by an informative text, you will learn all the stars and constellations visible from the Northern Hemisphere. The second section features 23 star charts that help you explore smaller portions of the sky in greater detail, guiding you to individual stars, double stars, variable stars, nebulae, and distant galaxies! And DISCOVER THE STARS also guides you in exploring the moon and planets and helps you learn more about astronomy. If you have looked up at the stars and longed to know more – DISCOVER THE STARS is for you!

$10.95
Paperback, 9¼" x 7½"
#30155

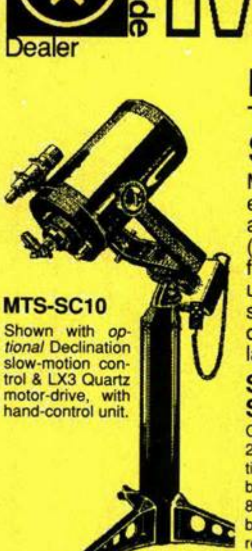
Available for shipment October 15, 1987

To order, use the ASTRONOMY order form bound into this issue, or send to ASTRONOMY Order Dept., 1027 N. 7th St., Milwaukee, WI 53233. Include for postage and handling: $U. S., $1; foreign $1.50. Wisconsin residents add 5% sales tax.

Authorized Meade Dealer

Meade

NEW from Meade!
The M-O-D-U-L-A-R
Schmidt-Cassegrains



MTS-SC10

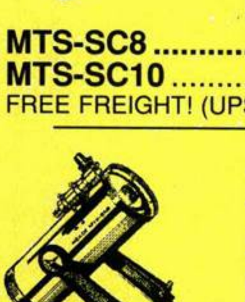
Shown with *optional* Declination slow-motion control & LX3 Quartz motor-drive, with hand-control unit.

Meade's newest system permits *you* to decide exactly how much telescope *you* want to buy, and when. The Schmidt-Cassegrain versions (shown at left) employ *exactly the same* diffraction-limited telescope tube assemblies used on Meade's much more expensive LX5 series telescopes (shown at right), at a fraction of the cost! Accessory systems may be added later, at *your* convenience and leisure.

STANDARD FEATURES & FACTORY SPECIFIED EQUIP - MTS-SC Series
Complete f/10 telescope tube assembly (8" or 10" aperture, 2,000mm [SC8] or 2,500mm [SC10] focal length), with certified diffraction-limited optical system; ultra-smooth anti-backlash focus mechanism; wide-field 6x30mm (SC8) or 8x50mm (SC10) straigh-thru finderscope with mounting bracket; 1.25" visual back; 1.25" diagonal prism, fully anti-reflection coated; 25mm MA eyepiece (80x or 100x), 1.25"; rugged dual-fork pier-type equatorial mount; latitude scale; pier with removeable tri-legs; dust covers for optical apertures; instruction manual; limited lifetime warranty.

MTS-SC8 .... (List: $1,400) .... **$ 789.95**
MTS-SC10 .... (List: $2,500) **$1,299.95**
FREE FREIGHT! (UPS Ground) for the MTS's shown above

totally NEW!
The M-O-D-U-L-A-R
Schmidt-Newtonians



MTS-SN8

Shown with *optional* Declination slow-motion control, LX3 Quartz motor-drive and finderscope.

Meade's MTS Schmidt-Newtonians are completely new. They feature ultra-fast (f/5 for the 6" version, f/4 for the 8") optical systems, along with Schmidt correctors to achieve razor-sharp images, and are ideal for wide-field, deep-space visual and photographic work.

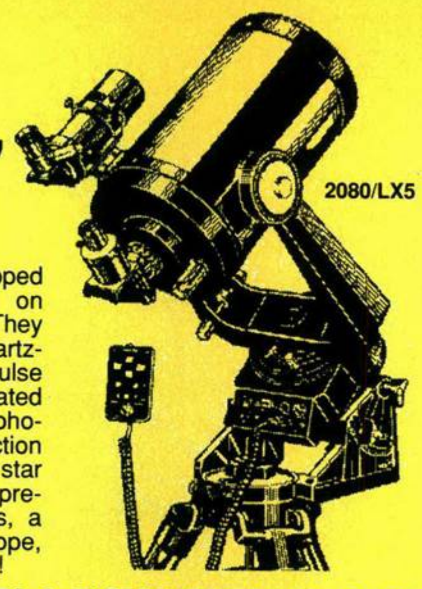
STANDARD FEATURES & FACTORY SPECIFIED EQUIP - MTS-SN Series
Complete telescope tube assembly (6" or 8" aperture, 760mm [SN6] or 810mm [SN8] focal length), with certified diffraction-limited optical system; ultra-smooth HELICOID focus mechanism; 25mm MA eyepiece (30x or 32.5x), 1.25"; rugged dual-fork pier-type equatorial mount; latitude scale; pier with removeable tri-legs; dust covers for optical apertures; instruction manual; limited lifetime warranty.

MTS-SN6 .... (List: $ 950) **$514.95**
MTS-SN8 .... (List: $1,400) **$789.95**
FREE FREIGHT! (UPS Ground) for the MTS's shown above

Accessories for MTS Telescopes

Optical Coatings (MCOG), for SN6	(List: $ 120.00)	**$ 69.95**
Optical Coatings (MCOG), for SC8, SN8	(List: $ 150.00)	**$ 89.95**
Optical Coatings (MCOG), for SC10	(List: $ 200.00)	**$129.95**
Setting Circle Set, with Pointers, for all	(List: $ 50.00)	**$ 34.95**
1-Axis (R.A.) AC Motor Drive, Model 788, for all	(List: $ 220.00)	**$139.95**
1-Axis (R.A.) DC Drive Corrector, for use with Mod. 788	(List: $ 130.00)	**$ 74.95**
1-Axis (R.A.) AC/DC Motor Drive, LX3 Mod. 790, for all	(List: $ 750.00)	**$429.95**
Manual Declination Control, Mod. 66A, for SN6, SC8	(List: $ 70.00)	**$ 49.95**
Manual Declination Control, Mod. 66C, for SN8, SC10	(List: $ 90.00)	**$ 64.95**
Electric Declination Sys, for use with Mod. 790 (req's 66A/C)	(List: $ 150.00)	**$ 89.95**
6x30mm St-Thru ViewFndr & Brkt, for SN6, SN8	(List: $ 70.00)	**$ 49.95**
8x50mm St-Thru ViewFndr & Brkt, for SN6, SN8	(List: $ 110.00)	**$ 74.95**
8x50mm RtAngle ViewFndr & Brkt, illuminated, f/SC8, SC10	(List $ 200.00)	**$149.95**

NEW! Meade 8" & 10" LX5's



The most fully-equipped Schmidt-Cassegrains on the market today! They come complete with quartz-lock microelectronic pulse motor drive, sophisticated hand control unit with photographic drive correction functions built-in, 2.00" star diagonal for advanced, premium-grade eyepieces, a giant 9x60mm finderscope, and much, much more!

STANDARD FEATURES & FACTORY-SPECIFIED EQUIP
Complete f/10 telescope tube assembly (8" or 10" aperture, 2,000mm or 2,500mm focal length), with certified diffraction-limited optical system; MCOG ("Multi-Coated Optics Group"), consisting of multi-layer anti-reflection coatings on corrector plate and enhanced reflectivity (multi-layer over-coated) mirrors; ultra-smooth anti-backlash focus mechanism; giant 9x60mm illuminated-reticle polar-alignment viewfinder with quick-disconnect mounting bracket; 2.00" mirror-type star diagonal, with 1/10 wave multi-coated mirror and adapter for 1.25" eyepieces; Series 4000 26mm Super Plossl eyepiece, 1.25" (77x or 96x); rugged dual-fork astronomical mount with graduated setting circles, manual positioning controls and clutches on both axes of motion; DIGITAL QUARTZ MICRO-ELECTRONIC SIDEREAL-RATE PULSE-MOTOR DRIVE SYSTEM and ultra-precision "LX" worm-drive gearing built into telescope drive base; POWER CONTROL PANEL (also built into drive base) WITH CONTROLS, INDICATORS and CONNECTORS for various accessory and auxiliary electronic equipment (includes input power connector; "on/off" switch, red LED indicator light; milliammeter to show current draw; "N/S" hemisphere switch; brightness adjustment knob for *optional* illuminated-reticle guiding eyepiece; power jacks for: (1) the "Drive Control" hand-control unit ["Electronic Command Center"], (2) *optional* declination control motor, (3) *optional* electric focuser, and (4) *optional* illuminated-reticle guiding eyepiece); ELECTRONIC COMMAND CENTER hand-control unit with: (a) quartz (fixed) or manual (variable) drive rate control switch, (b) variable (manual) drive-rate control knob (Lunar, Solar, Sidereal, etc.), (c) correction/scanning rate switch (2x & 8x the base drive rate), (d) red LED map-light, (e) map-light control button, (f) control buttons for *optional* electric focuser, (g) N-E-S-W drive correction control buttons, and coil-cord and plug for connection to telescope's Power Control Panel; AC power adapter with 25 ft. cord; DC battery-pack *(batteries not included)* with 4 ft. cord; 25 ft. DC power cord with automobile cigarette-lighter plug; Deluxe Equatorial Wedge with micrometric adjusters for latitude and azimuth polar-alignment adjustments, latitude scale, bubble level, magnetic compass (and no-tool knob set on 8" scope only), ultra-rigid adjustable-height Field Tripod; dust covers for optical apertures; foam-lined carrying case for scope-tube/fork-mount/drive-base assembly; audio cassette instructions on set-up and applications; instruction manual; limited lifetime warranty.

2080/LX5 MCOG (List: $3,600) **$1,689.95**
2120/LX5 MCOG (List: $5,200) **$2,489.95**
FREE FREIGHT! (UPS Ground) for the LX5's shown above

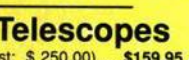
Accessories for LX5 Telescopes

Electric Focuser, Mod. 1200A, for 2080 or 2120	(List: $ 230.00)	**$149.95**
Electric Declination Motor, Mod. 39, for 2080 or 2120	(List: $ 160.00)	**$109.95**
Accessory Tray-Shelf for Field Tripod, for 2080 or 2120	(List: $ 40.00)	**$ 29.95**

Accessories for LX5, MTS-SC Telescopes

Electric Focuser, Mod. 1200, for SC8 or SC10	(List: $ 250.00)	**$159.95**
LensShade-DewShield, Mod. 712, for 2080 or SC8	(List: $ 90.00)	**$ 62.95**
LensShade-DewShield, Mod. 710, for 2120 or SC10	(List: $ 140.00)	**$ 97.95**
PIGGYBACK Bracket for camera, for 2080 or SC8	(List: $ 50.00)	**$ 36.95**
PIGGYBACK Bracket for camera, for 2120 or SC10	(List: $ 50.00)	**$ 36.95**
T-Ring for 35mm SLR camera (specify make)	(List: $ varies)	**$ 12.95**
T-Adapter for camera, Mod. 62, for all	(List: $ 50.00)	**$ 36.95**
Tele-Extender for eyepiece projection photography, for all	(List: $ 50.00)	**$ 36.95**
Off-Axis Photographic Guider System, complete, for all	(List: $ 250.00)	**$174.95**
Tube Balance Weight System, Mod. 1401, for 2080 or SC8	(List: $ 130.00)	**$ 90.95**
Tube Balance Weight System, Mod. 1402, for 2120 or SC10	(List: $ 140.00)	**$ 97.95**

Meade's Series 4000 Premium-Grade Eyepieces and Barlows in stock at low, low prices! Call for prices and recommendations . . . .



OUR GUARANTEE: We are solely, exclusively, professionally, a first-line, quality telescope dealership. We guarantee, unconditionally, that when you purchase a telescope or other equipment from us, you will receive all of the equipment and accessories that its manufacturer specifies for it. ***We do not*** "strip" scope kits, ***nor do we*** charge extra for the equipment, accessories or warranties intended by the manufacturers to be included with their equipment. When you buy from us, you will receive everything you pay for - you can count on it. We further guarantee, unconditionally, that all equipment sold by us is brand-new and factory-fresh. ***We do not*** take unscrupulous advantage of distant and helpless mailorder buyers; ***we do not*** buy and ***we do not*** sell ***RETURNED***, reconditioned, rebuilt, demonstrator, floor-sample, shopworn, used, loaner, rental, prototype, cosmetic defect, factory-second or otherwise imperfect goods. NO OTHER MAIL-ORDER DEALER, TO OUR KNOWLEDGE, MAKES AND PUBLISHES SUCH A GUARANTEE! DON'T BE FOOLED; BUY ONLY FROM A REPUTABLE DEALER.

california telescope company

CA & AK, or for information, call (818) 505-8424. Interbank wire transfers, DiscoverCard, MasterCard & Visa accepted - no surcharge. Free UPS Ground shipping in the contiguous 48 states. California shipping addresses add sales tax. Send business-size SASE for free Discount Price List; $5 ($8 foreign) postage and handling for Catalog Package. RFQ's welcome. Prices and specifications are subject to change without notice or obligation. All sales are final.

P.O. Box 1338, Burbank, California 91507
TOLL-FREE, ORDERS ONLY, 10-4 Pacific Time, Mon-Fri:
(800) 843-4780

CELESTRON

NEW from CELESTRON

POWERSTAR II

Celestron's newest incarnation of their classic fork-mounted Schmidt-Cassegrain is so advanced that it is *ONLY* offered with built-in QUARTZ microelectronic drive corrector (hand control unit included!) and STARBRIGHT optical coatings. AC or DC, N or S hemisphere operation, its ready-to-go!

STD. FEATURES & FACTORY SPECIFIED EQUIPMNT - PSC8 II

Complete f/10 telescope tube assembly (8" aperture, 2000mm focal length), with Celestron's world-famous, hand corrected, diffraction-limited, laser tested, individually certified ("Gold Standard") optical system; "STARBRIGHT" enhanced mirror coatings and "SPECIAL COATINGS" (anti-reflection coatings) on the corrector plate; widefield 8x50mm right-angle finderscope with built-in illuminated polar-alignment reticle; 1.25" visual accessory holder; high-brightness, enhanced-coatings mirror type 1.25" star diagonal; 26mm (77x), 1.25" barrel, multi-coated, premium-grade Plossl eyepiece; 7mm (285x), 1.25" barrel, fully coated, premium-grade, high-power Orthoscopic eyepiece; rugged dual-fork astronomical mount with graduated setting circles, manual positioning controls and clutches on both axes of motion; DIGITAL QUARTZ MICROELECTRONIC SIDEREAL-RATE PULSE-MOTOR DRIVE SYSTEM and ultra-precision 7.5" diameter "BYERS" worm-drive gearing built into telescope drive base; DRIVE CORRECTOR HAND CONTROL UNIT, with additional controls, and connectors for optional accessory electronic equipment (controls include "N/S" hemisphere switch, drive correction "rate" switch [2x or 4x the basic drive rate], N-E-S-W drive correction control buttons, drive rate adjustment knob [Lunar, Solar, Sidereal, etc.] for manual control of drive rate, red LED map-light, control switch for map-light, control switch and speed control knob for *optional* electric focus motor, connector for *optional* declination control motor, and coil-cord and plug for connection to telescope's drive base - note that the *optional* declination motor connects to either the hand control box or the telescope drive base, the *optional* focus motor connects only to the drive base); AC power adapter and cord/plug; DC battery-pack *(batteries not included)*; Deluxe Equatorial Wedge with micrometric adjusters for latitude and azimuth polar-alignment adjustments, latitude scale, bubble level and no-tool knob set; heavy-duty adjustable-height Field Tripod; dust covers for optical apertures; NEW EXTRA-RUGGED MOLDED CARRYING CASE FOR SCOPE-TUBE/FORK-MOUNT/DRIVE-BASE ASSEMBLY, WITH DIE-CUT FOAM LINING AND ROOM FOR ACCESSORIES; Instruction Manual; limited lifetime warranty.

PwrStr-C8 II ...... (List: $3,000) **$1,679.95**

FREE FREIGHT! (UPS Ground) for the PS-C8 II shown above

Accessories for PS-C8 II Telescopes

DEWSTAR LensShade/DewShield, for C8 Tubes	(List: $ 24.00)	**$ 19.95**
Electric Focuser, for PS-C8 II	(List: $ 150.00)	**$ 99.95**
Electric Declination Motor, for PS-C8 II	(List: $ 130.00)	**$ 89.95**
PIGGYBACK Bracket for camera, for C8 Tubes	(List: $ 50.00)	**$ 36.95**
T-Adapter for camera, for C8 Tubes	(List: $ 40.00)	**$ 29.95**
Off-Axis Photographic Guider System, complete, for C8 Tube	(List: $ 250.00)	**$174.95**
Counterweight Bar Assembly, with weights, for C8 Tube	(List: $ 150.00)	**$ 99.95**

C11, StrBrt, W&T List:$ 7,570.00 .... **$ 3,749.95**

C14, StrBrt, W&T List:$14,770.00 .... **$ 7,599.95**

SUPER POLARIS C8

The SP-C8 is *still* your best dollar-value in a full-featured, significant-aperture, astronomical telescope. The complete kit includes *exactly the same* diffraction-limited 8" Schmidt-Cassegrain telescope tube assembly used on Celestron's much more expensive PwrStar C8 (shown at left), along with a high-quality German-type Equatorial Mount and adjustable Tripod that is loaded with standard features and capabilities, such as built-in *worm-gear* slow-motion controls on *both* axes of motion, setting circles and clutches on both axes, built-in micrometer azimuth and latitude adjusters, bubble level, and *built-in illuminated-reticle polar-alignment telescope!*

STANDARD FEATURES & FACTORY-SPECIFIED EQUIP

Complete f/10 telescope tube assembly (8" aperture, 2000mm focal length), with Celestron's world-famous, hand corrected, diffraction-limited, laser tested, individually certified ("Gold Standard") optical system; widefield 6x30mm straight-thru finderscope; 1.25" visual accessory holder; high-brightness, enhanced-coatings mirror type 1.25" star diagonal; 26mm (77x), 1.25" barrel, multi-coated, premium-grade Plossl eyepiece; piggyback camera bracket; hand strap for holding telescope tube assembly during setup and takedown; quick-mount slider bracket for mounting and balancing scope tube; German-type equatorial mount with: (1) full 360° worm-drive slow-motion/manual-positioning controls on both axes (with anti-backlash adjustments), (2) setting circles on both axes, (3) vernier brake/clutches on both axes, (4) micrometer latitude adjustment (0-90°!) with latitude scale, (5) micrometer azimuth adjustment, (6) bubble level, (7) built-in (in the polar axis shaft) illuminated-reticle polar alignment telescope, (8) sliding-type counterweight (for quick adjustment) on quick-disconnect counterweight shaft (for quick setup and takedown), and (9) vibration-damping adjustable wooden tripod with accessory tray; foam-lined carrying case for telescope tube assembly; dust covers for optical apertures; instruction manual; limited lifetime warranty.

SP-C8 .... (List: $1,620) .... **$ 949.95**

SP-C8 StrBrt .... (List: $1,800) **$1,099.95**

FREE FREIGHT! (UPS Ground) for the SP-C8's shown above

Accessories for SP-C8 Telescopes

8x50mm St-Thru/RtAngle Finder & Mounting Bracket	(List: $ 200.00)	**$ 99.95**
1-Axis DC MotorDrive/Corrector	(List: $ 220.00)	**$149.95**
2-Axis DC MotorDrive/Corrector	(List: $ 380.00)	**$269.95**
2-Axis DC SKYSENSOR Computer Drive/Corrector	(List: $ 950.00)	**$599.95**
DEWSTAR LensShade/DewShield, for C8 Tubes	(List: $ 24.00)	**$ 19.95**

CompuStar

Celestron's CompuStar C8

Celestron's *CompuStar* computer-controlled telescopes are the most awesomely powerful instruments available to the amateur astronomer today. With coordinates and data on over 8,000 astronomical objects stored in its memory, and high-rate slew speeds, CompuStar can take you on a tour of the universe that must be experienced to be comprehended. Even a partial listing of CompuStar's features, functions and capabilities is too extensive to attempt here. Please write or call for additional information, pricing and delivery estimates, or send $10.00 cash, U.S., for our CompuStar Introductory Documentation Package.

NOTE: WE SPECIALIZE IN CompuStar RETROFIT "COMPUTERIZATION" OF C11's AND C14's. PLEASE CONTACT US REGARDING PRICE, DELIVERY AND OTHER DETAILS INVOLVED IN UPGRADING YOUR C11 OR C14 TELESCOPE.

CC8, StrBrt, W&T .. (List: $ 6,680.00) .. **Call**

CC11, StrBrt, W&T .. (List: $13,570.00) .. **Call**

CC14, StrBrt, W&T .. (List: $21,570.00) .. **Call**

OUR GUARANTEE: We are solely, exclusively, professionally, a first-line, quality telescope dealership. We guarantee, unconditionally, that when you purchase a telescope or other equipment from us, you will receive all of the equipment and accessories that its manufacturer specifies for it. ***We do not*** "strip" scope kits, ***nor do we*** charge extra for the equipment, accessories or warranties intended by the manufacturers to be included with their equipment. When you buy from us, you will receive everything you pay for - you can count on it. We further guarantee, unconditionally, that all equipment sold by us is brand-new and factory-fresh. ***We do not*** take unscrupulous advantage of distant and helpless mailorder buyers; ***we do not*** buy and ***we do not*** sell ***RETURNED***, reconditioned, rebuilt, demonstrator, floor-sample, shopworn, used, loaner, rental, prototype, cosmetic defect, factory-second or otherwise imperfect goods. NO OTHER MAIL-ORDER DEALER, TO OUR KNOWLEDGE, MAKES AND PUBLISHES SUCH A GUARANTEE! DON'T BE FOOLED; BUY ONLY FROM A REPUTABLE DEALER.

california telescope company

CA & AK, or for information, call (818) 505-8424. Interbank wire transfers, DiscoverCard, MasterCard & Visa accepted - no surcharge. Free UPS Ground shipping in the contiguous 48 states. California shipping addresses add sales tax. Send business-size SASE for free Discount Price List; $5 ($8 foreign) postage and handling for Catalog Package. RFQ's welcome. Prices and specifications are subject to change without notice or obligation. All sales are final.

P.O. Box 1338, Burbank, California 91507
TOLL-FREE, ORDERS ONLY, 10-4 Pacific Time, Mon-Fri:
(800) 843-4780

ASTRONOMY's 1987 Guide to Telescopes

Bewildered? Overwhelmed by too many choices? First-time telescope buyers often tell us they hardly know where to begin. Second-time buyers often wonder where to find the telescope that's right for them. This special section of ASTRONOMY will help you choose a telescope to begin — or extend — your exploration of the cosmos.

Refractor, reflector, or catadioptric? There's a lot to think about when making that basic decision. What sort of observing do you want to do — lunar and planetary, deep-sky, or a bit of everything? Which is most important — sharp images, bright images, or a compromise between brightness and sharpness?

What do all those specifications with funny-sounding names mean? Who needs a clock drive? Why? Which of the hundreds of models on the market come with clock drives, and which come without? Which have finders, and which don't? How many eyepieces are included in the list price? How much do all those extra features cost? Can you do without, or should you get them because they're useful?

Buying a telescope isn't easy. There are so many questions that need answers. We hope this guide will help you find those answers.

Do Your Homework before You Buy 48

The telescope buyers' guide to purchasing wisely.

ASTRONOMY Equipment Directory 1987 Insert

Listings for three hundred manufacturers and retail outlets.

The Refractor Advantage: Quality over Size 66

If you're after image quality, refractors deliver.

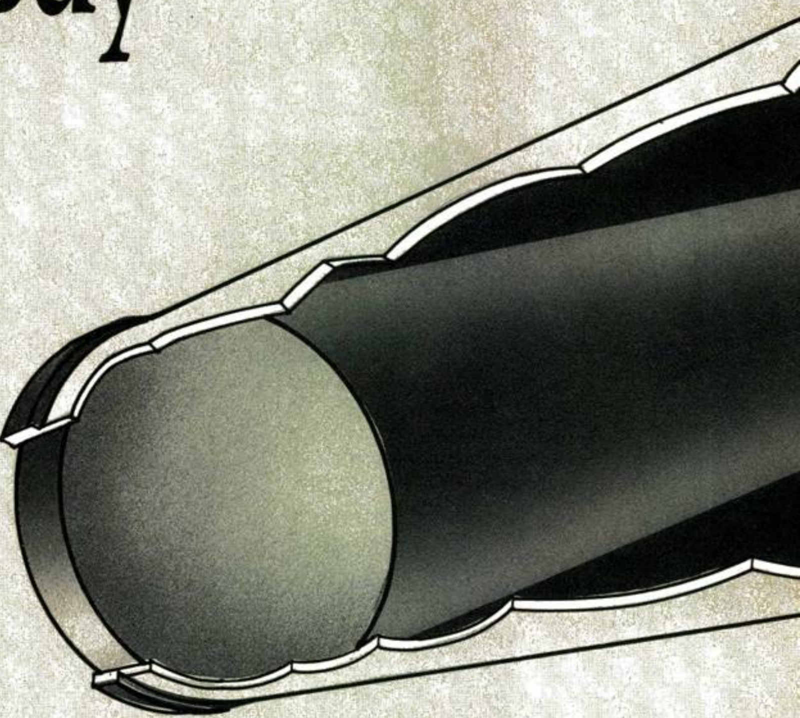
1987 Telescope Buyers' Guide 74

Feature-by-feature profiles of 151 popular telescopes.

Illustrations by Bryan Peterson

Do Your Homework before You Buy

by Bill Volkart



Unpacking your first telescope is almost as much fun as using it the first time. You lift the lid from the heavy cardboard box, inhale that singular techno-aroma of lubricant and paint, remove the plastic covers and Styrofoam packing material, and see the shiny tube lying there full of promise — it's like opening a long-sought treasure chest. Your excitement surges as you anticipate the enthralling images of planets, star clusters, and galaxies your telescope will show you. Before you take it out of the box, you're convinced that this telescope was the best choice you ever made.

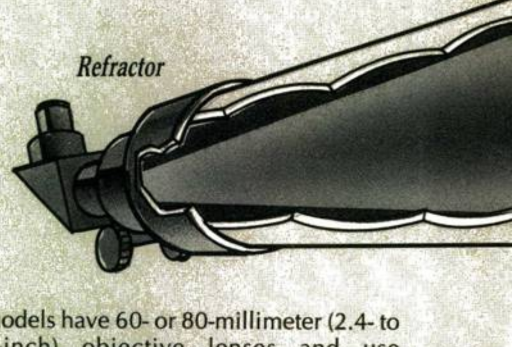
Let's hope you still believe this after you've begun using it. Without a doubt, choosing a first telescope is one of the most crucial decisions you will make as an amateur astronomer. Unfortunately, the path to a confident decision is as fraught with pitfalls as any flea market. Buyers are faced with a bewildering number and variety of telescopes in magazines, department and camera stores, and catalogs; each telescope has quality optics at an affordable price, claim the advertisements. Like cars and high-fidelity equipment, telescopes are often described with terms unfamiliar to the uninitiated, such as "focal ratio" and "resolution." Moreover, the buyer usually cannot "test drive" his telescope until after he has laid his money down (an enormous advantage to dealers and manufacturers), so a buyer's decision is often based on great expectations instead of firsthand experience.

Obviously, the best choice is a good quality telescope that suits your needs and budget. You want a telescope that produces sharp, bright images; is easy to set up and use; and allows you to evolve as an amateur astronomer. Such a telescope will nurture your interest and provide years of enjoyment.

How do you make a decision you won't regret? First you need to learn a few basic facts about telescopes so you can read between the lines of advertising copy and find the essentials that can help you make a wise decision.

Let's begin by reviewing the pros and cons of the three most common types of telescopes: the refractor, the reflector, and the catadioptric. As well-defined as these three categories are, people still misconstrue how telescope design translates into performance.

Refractors



The classic lines of a refractor are what most people picture when the word telescope is mentioned: a long tube with a lens (called the objective) at one end and an eyepiece at the other. The objective lens bends incoming light, so the rays come to a focus at the opposite end of the tube.

Most refractor objectives are composed of two lenses: a convex lens and a concave lens, each made of a different kind of glass. Two types of lenses are used because a single piece of glass can't bring different colors of light to the same focus — a problem called chromatic aberration. Stars seen through a telescope with a single-element objective are fringed in color. But the marriage of a convex lens made of low-density crown glass and a concave lens made of high-density flint glass cancels out this effect and produces nearly color-free images. This type of two-element objective is called an achromatic lens.

The most popular department store models have 60- or 80-millimeter (2.4- to 3-inch) objective lenses and use 0.965-inch-diameter eyepieces. Though usually adequate for bright objects like the Moon, this class of refractor suffers from several drawbacks.

For one thing, you can't upgrade to a larger diameter eyepiece. The standard 1.25-inch-diameter eyepiece used on most telescopes will not fit a 0.965-inch barrel. This isn't a problem if you plan to stick with the smaller eyepiece size. However, the variety of eyepieces available in the 1.25-inch size (and the increasingly popular 2-inch size) are not available for scopes with 0.965-inch eyepiece barrels.

To make matters worse, these small-diameter eyepieces are often poor in quality. To use the high-magnification 0.965-inch eyepieces, you must practically place your eye on the eye lens — the component closest to the eye — to see anything, and even then you have to hold your head very still to keep the image in the field of view. This problem is compounded if the seeing is poor or the optical components of the telescope are flawed. Thus, the high magnification so widely touted by the advertisers of these scopes is virtually useless, even for lunar and planetary observations.

Another problem with the average department store refractor is that it often comes with an insufficient mount. Spindly legged tripods that are inadequately braced or designed to be set on a card table or car hood are to be avoided. Examine the mount carefully. The legs should be made of hardwood or metal, and they should have adequate cross bracing. An accessory shelf is a handy item that also strengthens the overall structure. The head of the mount should allow the telescope to move freely without excessive vibration or slop.

In recent years a number of advancements have improved refractor optics. The result is a line of larger, more expensive, and higher quality telescopes. By making one of the objective elements from calcium fluoride rather than glass, lens designers have virtually eliminated chromatic aberration. Unfortunately, this material is expensive and telescopes that feature calcium fluoride objectives are more costly.

Another modification to correct the color problem is a third lens added to the objective. Such objectives are called apochromatic lenses. Although not as expensive as the calcium fluoride objectives, apochromats are nevertheless more costly than achromats because lens

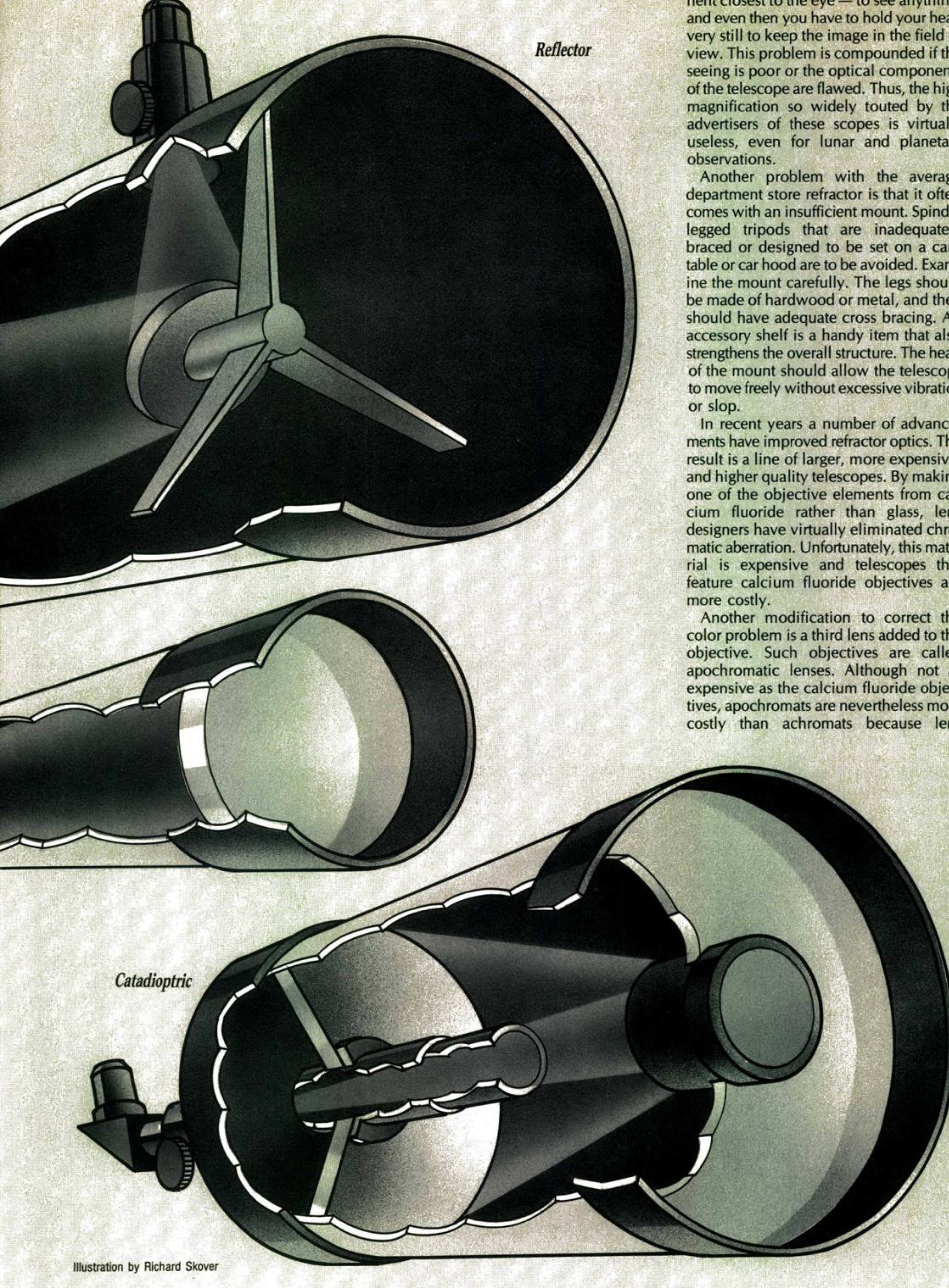


Illustration by Richard Skover

makers must correctly figure *six* glass surfaces instead of four. Moreover, the special glass used in making apochromats is more expensive than the glass used in ordinary two-element lenses.

Refractors generally provide crisp images and dark sky backgrounds. Because refractor tubes are closed and light is bent away from the tube wall as it is brought to focus, images don't suffer from internal air turbulence. So they are well-suited for lunar, planetary, and double-star observing and equally adequate for viewing bright deep-sky objects.

Reflectors

Since its invention by Isaac Newton in 1668, the Newtonian reflector has remained basically the same, although, like refractor optics, reflector optics have been improved significantly over the years. A reflector uses a concave mirror to reflect light to a secondary mirror, which in turn diverts the rays into an eyepiece. Because of this simple arrangement, reflectors have remained popular with professional and amateur astronomers for over three hundred years.

In comparison with telescopes of similar size, reflectors cost less to make than refractors do, mainly because only two optical surfaces have to be worked. Hence, a large-aperture reflector can be built and sold for far less than a small-aperture refractor and because larger aperture means greater light grasp, you get more light-gathering power for your dollar with a reflector — a very attractive combination for amateur astronomers on a budget.

Because reflectors don't pass light through glass, images are free of color fringing. A well-figured mirror, then, can yield crisp views of the Moon, planets, and double stars. Generally, reflecting telescopes offer wide fields of view, which make them ideal for deep-sky observing and astrophotography. Some reflectors, in particular the Dobsonians, are specifically designed to gather as much light as possible for observing faint deep-sky objects.

But no telescope is perfect. One drawback of reflectors is that the primary mirror tends to get knocked out of alignment with the secondary if the telescope is moved about roughly or transported in a car over bumpy roads. When this happens, the primary mirror, suspended on a mount at the base of the tube, must be realigned by adjusting screws in the mirror mount. This usually involves turning the screws slightly to bring the mirror back into alignment.

Keeping reflector optics clean is another problem. Because the mirrors are housed in an open tube, they eventually accumulate dust and grime and must be cleaned every two years or so.

Despite these limitations, the reflector is a versatile instrument that performs as capably as the refractor or catadioptric but is priced to fit within most budgets.

Catadioptrics

The catadioptric — lens and mirror — telescope combines many of the best qualities of both refractors and reflectors and is conveniently portable. The most popular "cat" design is the Schmidt-

Eyepieces to Complement Your Scope

A major problem the first-time telescope buyer must face is the seemingly endless variety of eyepieces available. Strange names like Kellner, Orthoscopic, and Plossl abound in magazine advertisements. Though there is a considerable number of designs to choose from, you need only learn about a few of the mainstream eyepieces to build a useful set.

Most common to small "department store" refractors are the simple two-lens design Huygens and Ramsden eyepieces. They are generally only good for telescopes with long focal ratios (f/15), because their image quality suffers greatly at lower focal ratios. They are often poorly made and should be avoided unless you can try one out on your instrument first or if cost is a major factor.

More acceptable is the Kellner eyepiece. Its three-element design produces good images at low to medium powers and is color-corrected. Kellners offer better eye relief, though some suffer from "ghosts," which appear as fuzzy, unresolved areas caused by reflections of a bright star or planet in the field. For the most part, Kellners work well, though their usefulness is limited in telescopes with focal ratios of f/6 and lower.

The Orthoscopic eyepiece employs four lens elements and provides a flatter, more distortion-free field of view. Ghosts in the image are virtually eliminated, as are color aberrations.

The Plossl eyepiece renders flat, wide fields with negligible ghosts in telescopes with low focal ratios. As a result, they have become very popular in recent years. Plossls are expensive, but a four-piece set ranging from 28mm to 6mm will serve admirably. If you own a Dobsonian with a focal ratio of f/4.5, these eyepieces are highly recommended.

Then there are observers who like the feeling of "being there." The wide-angle eyepieces known as Erfles and Naglers provide immense, very flat fields of view that give the image a picture-window feel. These eyepieces employ five or six lens elements, so sharp images extend all the way to the edge of their wide fields. — *P.V.*

Essentials of Telescope Performance

Focal Length

The focal length is the distance from the center of the objective to the focal point. Long focal lengths translate into large images at the focal plane.

$$\text{focal length} = \text{aperture} \times \text{focal ratio}$$

Focal Ratio

The ratio of the focal length of a telescope to its aperture is the focal ratio. A telescope's focal ratio gives you an idea of the size of the field of view in a given eyepiece. For a given aperture, the smaller the focal ratio, the larger the field of view.

$$\text{focal ratio} = \frac{\text{focal length}}{\text{aperture}}$$

Magnification

Magnifying power corresponds to the angular size of an object in a telescope with a given eyepiece — not the amount of detail that can be seen.

$$\text{magnification} = \frac{\text{focal length}}{\text{eyepiece focal length}}$$

Resolving Power

Resolution refers to the amount of detail that can be seen with a telescope. It is a measure of the smallest angular distance (in arcseconds) between two close, but distinct pointlike objects that the telescope can "split." Resolving power increases with aperture.

$$\text{resolution} = \frac{4.56}{\text{aperture (in inches)}}$$

Light-Gathering Power

The measure of a telescope's ability to detect light and thus faint objects is the telescope's light-gathering power. A telescope's "limiting magnitude" (faintest star visible under excellent seeing conditions) is derived from this equation.

$$\text{light-gathering power} = \left(\frac{\text{aperture (in millimeters)}}{\text{6mm}}\right)^2$$

— or —

$$\left(\frac{\text{aperture (in inches)}}{0.25''}\right)^2$$

Eyepiece illustrations by Bruce Bond

Cassegrain telescope, or SCT. This design, as well as its close relative the Maksutov-Cassegrain, has a spherical rather than a parabolic mirror as the objective. In addition, a "corrector lens" is placed at the front of the tube to remove distortion at the edge of the field caused by the spherical mirror.

After passing through the corrector lens, the light follows a "folded" path that takes it from the primary mirror to the secondary mirror (mounted on the back of the corrector lens), where the light is reflected back down the tube and through a hole cut in the center of the primary mirror. This design produces fairly large images at the focus — like a refractor — but the tube length collapses to only twice to three times as long as the diameter. This makes a portable, easy-to-set-up telescope that produces sharp images across the field of view.

Because of the degree of perfection required in figuring and aligning the optical surfaces, catadioptrics are expensive compared with Newtonian reflectors. Nevertheless, they are versatile, portable, and their image quality is excellent. Commercial Schmidt-Cassegrains usually come with a clock drive and innumerable options — from a computer-controlled mount to special optical coatings. For the serious amateur who can afford the $1,000-and-up price tag, Schmidt-Cassegrains are highly recommended.

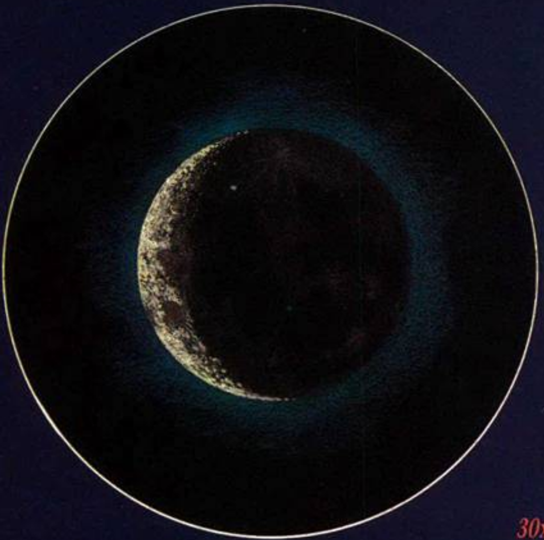
Performance Factors

Focal length, focal ratio, and useful magnification, not to mention the sharpness of the image, are important, mathematically related factors associated with telescope performance. Put simply, focal length is the distance from the center of a reflecting or refracting surface to the focus. The longer the focal length, the larger the image. Though you might assume that a large image is ideal, this is not always true.

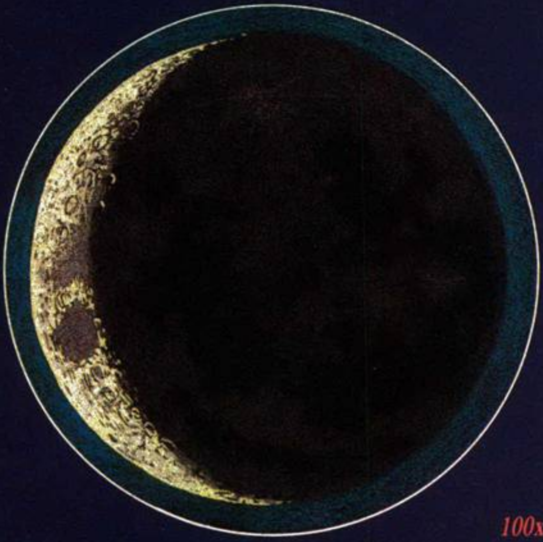
A focal length of 1,200 millimeters (48 inches) yields an image of the Moon that is about half an inch in diameter at the focal plane. Focal lengths in the 2,000-millimeter range produce a Moon image that is a little over three quarters of an inch across. Telescopes can be constructed with practically every variation of focal length and aperture imaginable, but some combinations are patently unacceptable for some types of observing. For example, a telescope with a long focal length and a too-small aperture yields large images at the focal plane. An object as bright as the Moon or a planet is fine for such an instrument, but what about a faint, extended galaxy? Such an object at too large a scale will be difficult to observe, because its light will be spread out in the field. Unless you increase the aperture or reduce the focal length, you won't see much detail in faint deep-sky objects. Not only that, the field of view will also be limited.

One way to assess the field of view a

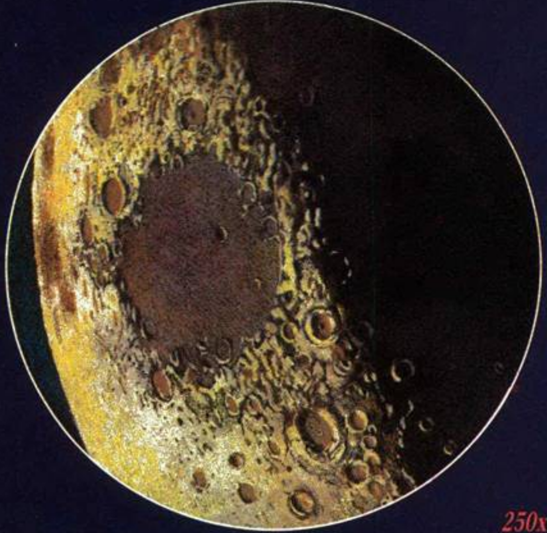
Magnification: How Big?



30x

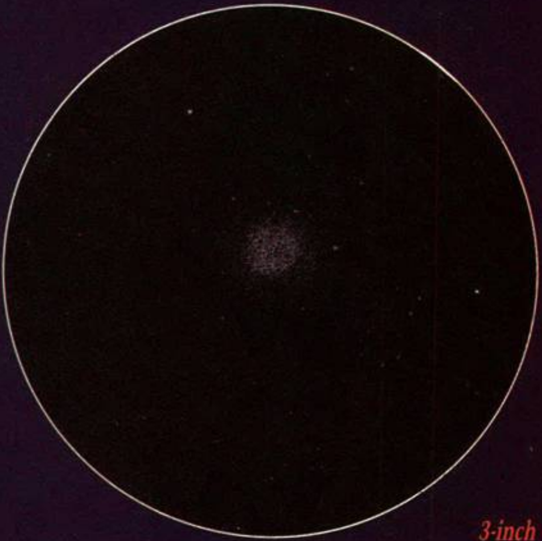


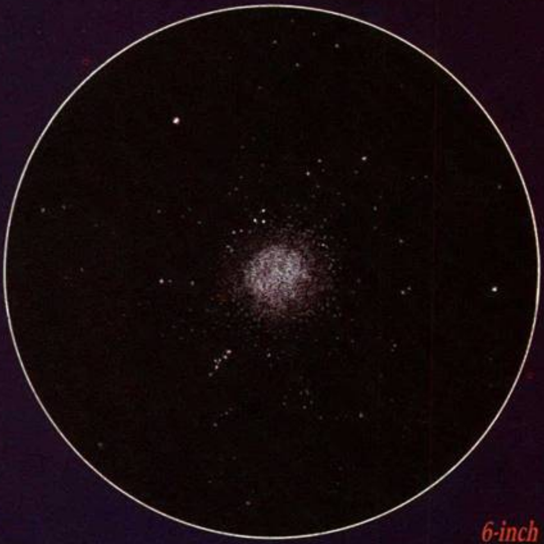
100x

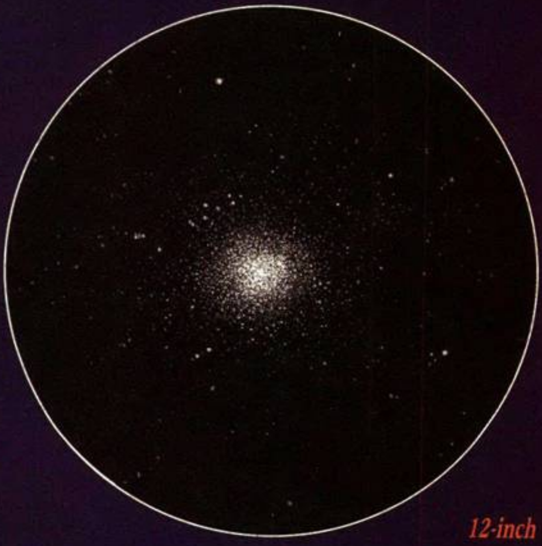


250x

Light-Gathering Power: How Bright?


3-inch


6-inch


12-inch

telescope will produce is noting the focal ratio, which is calculated by dividing the telescope's focal length by the diameter of the objective lens or mirror (measured in the same units). For example, a 6-inch Newtonian with a 48-inch focal length has a focal ratio of f/8. A 6-inch Newtonian with a focal length of 30 inches has a focal ratio of f/5. The second scope has a shorter focal length and thus produces a smaller image scale and a larger field of view. Images in this scope will be smaller but brighter if you use the same eyepiece; faint deep-sky objects will be a little easier to observe than in the first telescope.

A large-aperture reflector, such as a 13-inch Dobsonian with a focal ratio of f/4.5, is an impressive light-gatherer that produces bright images in a large field of view.

Calculating the magnification of a given eyepiece is equally simple. Just divide the focal length of the telescope by the focal length of the eyepiece.

Let's use the example of an 8-inch reflector with an focal ratio of f/4.5. We want to know both the focal length of the telescope and the magnification produced with a 25mm eyepiece. First convert the mirror diameter to millimeters because the eyepiece is in millimeters (25.4mm = 1 inch). An 8-inch mirror works out to be about 200mm. The focal length, then, is equal to 4.5 x 200mm or about 900mm. Now find the eyepiece magnification by dividing 900mm by 25mm. This gives a magnification of 36 power.

With these simple formulae it is possible to determine the magnification of this eyepiece on any telescope. For instance, this same eyepiece used in an 8-inch SCT with a focal ratio of f/10 would produce a magnification of 80x.

Magnifications above 400x are seldom useful with any telescope. As a general rule, most of your low-power observing will be in the range of 4x per inch of aperture (lens or mirror diameter) with 8x per inch as a medium magnification and 30x per inch about the useful maximum. Therefore, if you own a 3-inch refractor, your maximum useful magnification is 90x with a typical range of from 12x to 24x. An 8-inch reflector would have a maximum magnification of 240x with a typical range of from 32x to 64x on most average nights.

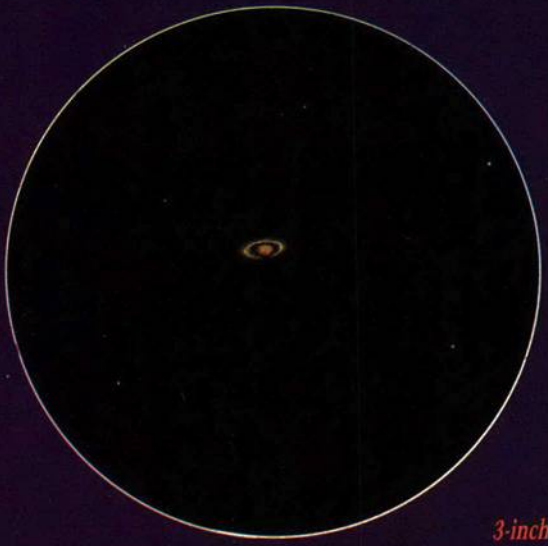
All amateurs should have at least one low-power eyepiece for sky sweeping and locating diffuse or low surface brightness objects. Once you find an object in this manner, you can examine it further at greater magnification.

As you can see, understanding focal ratios and focal lengths will improve your ability to evaluate a particular telescope's performance, as well as how to choose the proper eyepieces for that telescope.

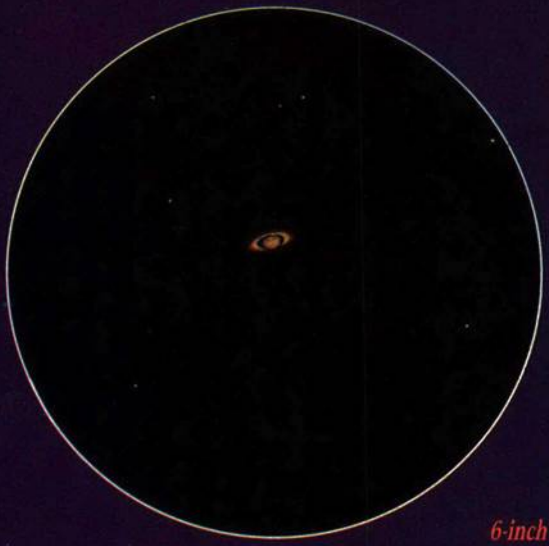
Telescope Mounts

No telescope, no matter how good it is, is worth having if it is compromised by a shaky, unstable mount. Of course you can

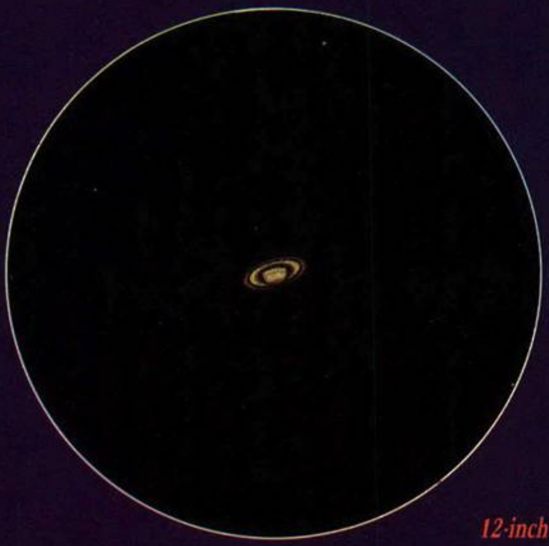
Resolution: How Much Detail?



3-inch



6-inch



12-inch

always buy a more expensive mount later, but you shouldn't have to buy two mounts. When you're thinking about buying a telescope, consider what it will be mounted on. Ask yourself if the mount is worth the price of the telescope package.

There are two types of mounts and variations within each type. The simplest is the altazimuth, a term derived from the words altitude and azimuth. Such a mount allows the instrument to be swung in altitude (up and down) and azimuth (side to side).

Most small refractors and reflectors come with altazimuth mounts. These are horseshoe shaped and fixed to the tube by trunnions or a tube cradle ring. The better mounts come with "slow-motion controls," cables or knurled knobs that allow you to track the stars manually by turning both altitude and azimuth controls.

But the altazimuth mount is not just for small telescopes. The Dobsonian mount, which is an altazimuth design, can support reflectors up to twenty inches and greater. The tube is placed within a wooden box that rotates at the base and allows the telescope to easily move up and down on Teflon bearings. Dobsonian mounts are noted for their stability and smoothness, not to mention their low cost. Their simple design has even inspired many amateurs to construct their own.

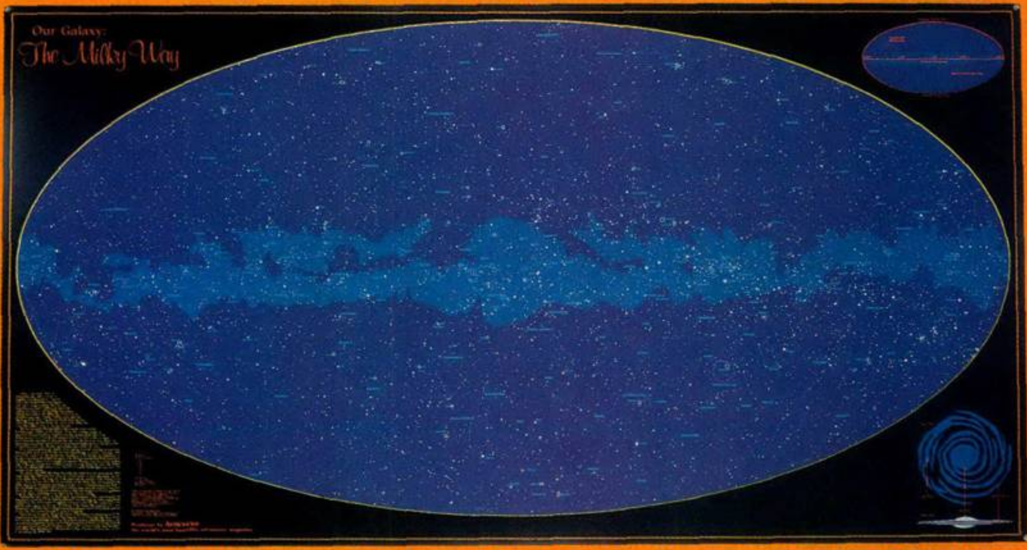
A disadvantage of the altazimuth mount is that it can only be adjusted to track the stars in two axes, which makes it a purely visual telescope mount. To be able to track the stars automatically, one axis must be oriented parallel to the Earth's rotational axis.

This is achieved in the second type of mount, called an equatorial. The equatorial consists of two axes: polar and declination. The polar axis is set parallel to Earth's rotational axis; the declination axis is at right angles to the rotational axis. The telescope simply rotates around the polar axis to track the stars. If you want the telescope to track the stars automatically, the mount needs to be equipped with a clock drive to turn the scope at the same rate the stars move across the sky.

The telescope you buy doesn't have to be the largest or the most expensive model, nor does it need to be decked out with myriad accessories to be a useful and capable tool. It just has to please you. If it does, you made the right choice. That's why it's important to learn all you can about the different telescopes *before* you spend your money. After you make your purchase, you can learn more about the celestial gems you discover and share the experience with the people closest to you. That's the best part about owning a telescope.

Bill Volkart is an engineering designer who lives in Cincinnati, Ohio. He is an active amateur astronomer and enjoys deep-sky observing.

OUR GALAXY: THE MILKY WAY
9100 Stars and 250 Deep Sky Objects on a 36″ x 68″ Wall Chart!



"You have to see it! . . . well worth the money." Gary Pittman, Astronomical Society of Kansas City

It's incredible . . . a huge, dramatic – and scientifically accurate – color wall chart showing all the stars visible in the night sky! OUR GALAXY: THE MILKY WAY features 9100 stars, hundreds of star clusters, nebulae, and galaxies, plus the constellations. This beautiful wall chart shows every star visible from Earth, but with a "cosmic" viewpoint – at the center of the chart is the nucleus of our Milky Way Galaxy. OUR GALAXY: THE MILKY WAY is a striking, dramatic addition to any room or observatory – order your copy today!

$16.95
#18529

Shipped in a sturdy mailing tube.

To order, use the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., 1027 N. 7th St., Milwaukee, WI 53233. Include for postage and handling: U. S. $1; foreign $5.50. Wisconsin residents add 5% sales tax.

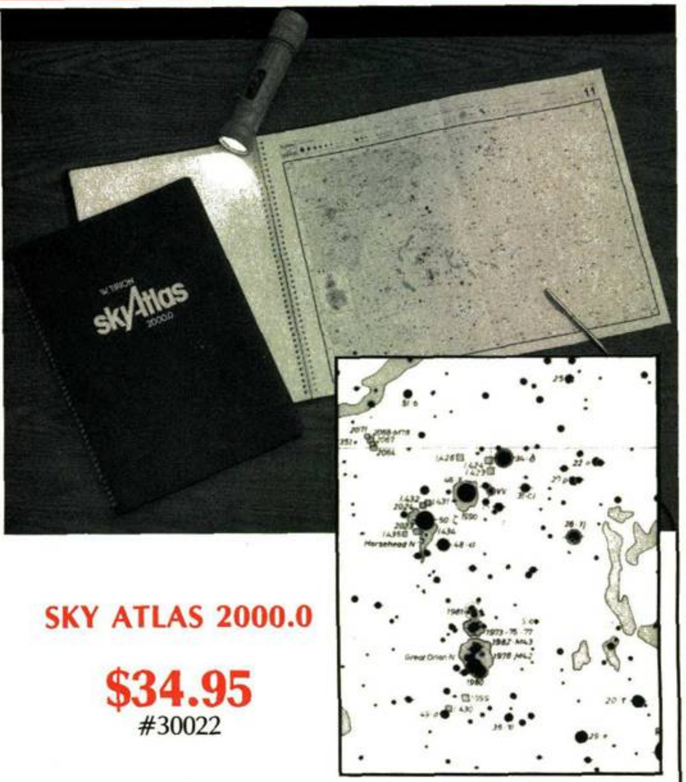
Sky Atlas 2000.0

Join the ranks of knowledgeable amateur astronomers with the **Sky Atlas 2000.0**. Find your way to galaxies, star clusters, and nebulae with ease. These giant star maps are crisp and distinct — and they're beautifully illustrated in color. Even the armchair astronomer will enjoy tracking down favorite nebulae and galaxies and other celestial objects seen in ASTRONOMY.

- 26 charts encompassing both hemispheres
- Each jumbo chart 12½″ x 17½″
- 43,000 stars — to the 8th magnitude
- 2,500 color-coded deep-sky objects
- Clearly-defined constellation boundaries
- All Messier objects and thousands of NGC objects
- Celestial coordinates for the year 2000
- Handy reference key on each chart

Also available:
Sky Catalogue 2000.0
Vol. 1 temporarily out of stock
distances. Paperback, #30023 **$29.95**.

Sky Catalogue 2000.0 Vol. 2, 385 pages cover 21,800 deep-sky objects, includes galaxies, variable stars, clusters, globulars, quasars, radio, and X-ray sources. Paperback, #30024 **$29.95**.



SKY ATLAS 2000.0

$34.95
#30022

To order, use the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., 1027 N. Seventh St., Milwaukee, WI 53233. Include for postage and handling: U.S. $1; foreign $1.50. Wisconsin residents add 5% sales tax.

SOLAR SKREEN • ASTRO TULE • NO DU CAPS • SUPER FINDER • ULTIMATE FINDER • STEREOOCULAR

MICRO DRIVE • MINI MOUNT • SOLAR PROMINENCE PROBE • ISOSTATIC MOUNT • CELESTIAL NAVIGATOR

YOUR ASTRONOMICAL FRIEND ANNOUNCES: THE TUTHILL ASTRO VIDEO SEMINARS. FIRST IN A SERIES OF INSTRUCTIONAL VIDEO TAPES ON BASIC ASTRONOMICAL EQUIPMENT OPERATION AND ASTROPHOTOGRAPHY by ROGER W. TUTHILL.

Some of the subjects covered are: short cuts in set-up, how to understand and use setting circles, how to get quick and accurate polar alignment, straight talk about eyepieces and hints on astrophotography. Designed for the beginner as well as the advanced amateur. The sequence on optical collimation alone is worth the price! Two tapes now available: #1 Basic SCT operation - $50., #2 Advanced SCT astrophotography - $50. Get both for only $80 and save $20. **BOTH TAPES *FREE* WITH EVERY MEADE or CELESTRON SCT WE SELL.**

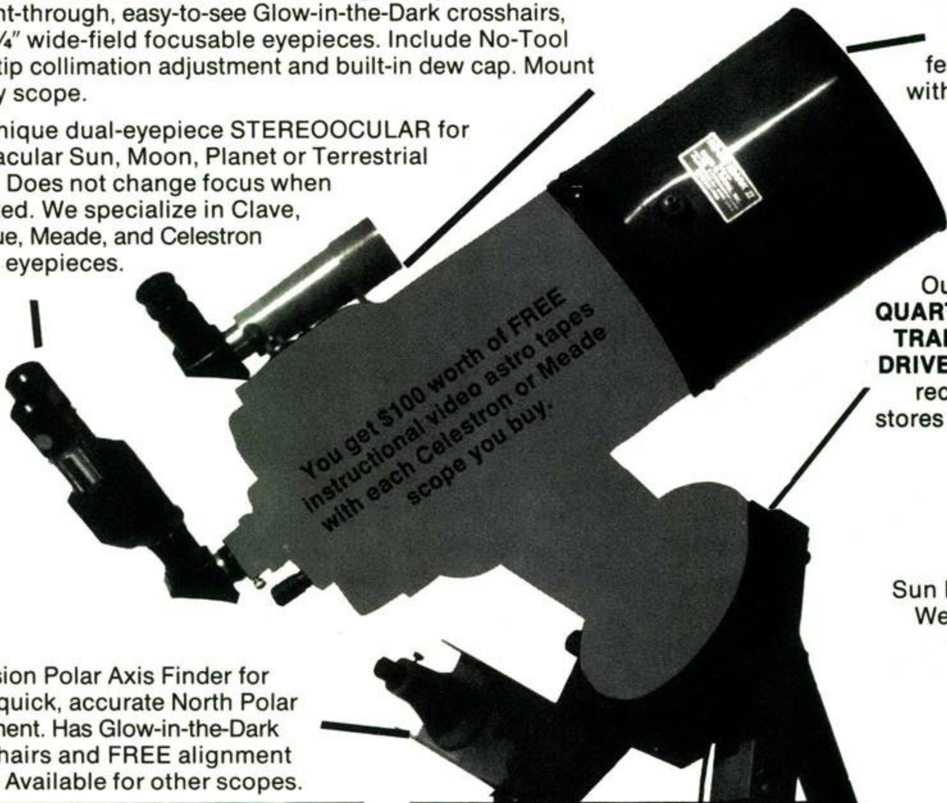
— These Video Tapes may be RENTED for as low as $20 each —

Giant Finders, 50mm & 80mm diam. right-angle and straight-through, easy-to-see Glow-in-the-Dark crosshairs, use 1¼″ wide-field focusable eyepieces. Include No-Tool fingertip collimation adjustment and built-in dew cap. Mount on any scope.

The unique dual-eyepiece STEREOOCULAR for spectacular Sun, Moon, Planet or Terrestrial views. Does not change focus when adjusted. We specialize in Clave, TeleVue, Meade, and Celestron Plossl eyepieces.

No-Du-Caps are lightweight, heated with moisture-absorbing features. Easily attach without tools for Meade 2080, 2120, C11 & C14 scopes.

Our **NEW CORDLESS QUARTZ - LOCKED STAR TRAP POWER MODULE DRIVE CORRECTOR** with rechargeable batteries stores inside the C8 base.


You get $100 worth of FREE
instructional video astro tapes
with each Celestron or Meade
scope you buy.

SOLAR SKREEN®
Sun Filters for all scopes.
We sell hydrogen alpha filters for all scopes.

Precision Polar Axis Finder for easy, quick, accurate North Polar alignment. Has Glow-in-the-Dark crosshairs and FREE alignment chart. Available for other scopes.

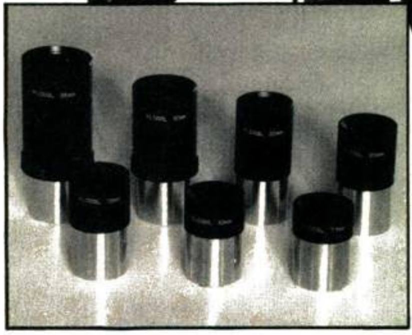
NEW Knot-Free Redwood Isostatic Equatorial Mount. A combination wedge and tripod with built-in latitude AND height adjustment. Includes 3 No-Tool knobs and vibration-resistant pads. Lightweight, folds up for easy portability and storage. For any size Schmidt-Cass. scope, Meade 2045, 2080, Questar, B & L 4000, C11 and C14.

ATTENTION ASTIGMATIC OBSERVERS!

CUSTOM-MADE EYEPIECE CORRECTIVE LENSES
From $45

TELE-VUE, MEADE, CELESTRON, CLAVE PLOSSL & WIDE FIELD EYEPIECES

We also sell all accessories and LUMICON and COULTER products.



**TUTHILL PLOSSL EYEPIECES
LOW COST/HIGH QUALITY
From $59.50**

**CALL TOLL-FREE 1-800-223-1063
TALK TO ASTRONOMERS — NOT CLERKS**

WE MAKE A SPECIALTY OF SOLVING PROBLEMS FOR BEGINNERS AS WELL AS ADVANCED AMATEURS. WE EXPORT SCOPES WITH ANY VOLTAGE AND FREQUENCY TO EITHER HEMISPHERE. WE REPAIR SCOPES.

**WE TRUST YOU —
WE SHIP THE SAME DAY WE GET YOUR PERSONAL CHECK
*(No waiting for your check to clear.)***

**TIME PAYMENT PLAN AVAILABLE.
MasterCard and VISA accepted.**

Send a large (9″ x 12″ 3 oz.) MANILA Self-Addressed Stamped Envelope (with three stamps) for our complete Information Kit including "Tuthill's Twenty-Two Telescope Tips" and the "Special Tuthill Maintenance Instructions for scopes and information on the NEW DIGITAL READOUT OF R.A. AND DEC CIRCLES."

ROGER W. TUTHILL, INC.

**Telephone: (201) 232-1786
11 Tanglewood Lane, Dept. A, Mountainside, NJ 07092**

ORION TELESCOPE CENTER

FREE CATALOG

Call Toll Free!

800-447-1001 In Calif. 800-443-1001

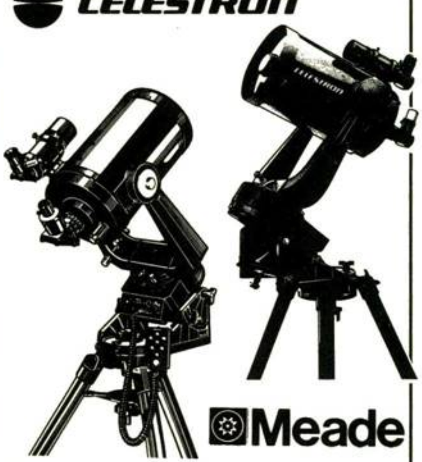
Orion Works For You!

When you buy your telescope or accessories from us, you can buy with confidence, knowing that Orion is the nation's largest independent telescope dealer. Attention to your needs has made us #1.

Telescopes & Accessories

Your #1 Source for Major Brands

CELESTRON



Meade

Tele Vue

ORION

BUSHNELL

Our 100% Satisfaction Guarantee

If you are not completely satisfied with your mail-order purchase from this ad for any reason, just return it in new condition within 30 days after delivery for a prompt refund.

You be the Judge!

New! Orion Enhanced™ Giant Binoculars

20% more light transmission than ordinary "fully coated" binoculars.

Fully Multi-Coated optics and superior BAK-4 prisms provide fantastic contrast and greatly improved edge sharpness. Includes lens caps, case, straps, tripod mounting bracket.

Enhanced 10x70 Binoculars Offer performance superior to standard 'fully coated' 11x80 models. #9501 **$249** (4.25)

Enhanced 11x80 Binoculars Exceed the performance of major brand competitive models. #9502 **$299** (5.30)

Affordable Deep Sky Binoculars

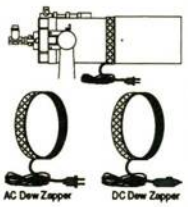
These well-made fully coated binoculars with BK-7 prisms offer impressive views of nebulas, galaxies and other deep-sky objects. Each include deluxe hard case, lens caps, straps, tripod mounting bracket.

10x70 Binocular #9505 **$199** (4.25)
11x80 Binocular #9506 **$249** (5.30)

Little Giant™ 9x63 Fully Multi-Coated Roof Prism Binoculars

Our Little Giants aren't just 'Coated Optics' or 'Fully Coated', they're *Fully Multi-Coated*, so every objective lens and prism surface is multi-layer coated for the absolute peak of optical performance. 6° field of view. Light weight (2.8 lbs.). Includes lens caps, case and straps. #9500 **$159** (3.29)

The Dew Zapper



Applies warmth to the perimeter of the corrector plate. Ideal for use at home or in the field. Works alone or along with any dew cap. For Meade or Celestron 8" Schmidt Cassegrains.

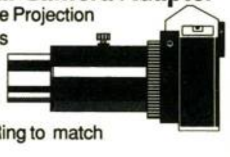
12 volt DC Dew Zapper Plugs into cigarette lighter receptacle. #3503 **$33.95** (1.60)

110 volt AC Dew Zapper Plugs into household 110 volt wall outlet. #3504 **$33.95** (1.60)

New Orion Brand Accessories. Save money without compromising quality.

These accessories are of the same grade as offered by major telescope manufacturers. Orion buys direct, so you save money. No middleman's markup.

Orion Universal Camera Adapter



Combination Eyepiece Projection Tube and Prime Focus Adapter for refractors and reflectors with 1.25" eyepiece holders. Use with T-Ring to match your 35mm camera. #5264 **$29.95** (1.60)

Orion Tele-Extender

Eyepiece Projection Tube for high powered photography through Meade or Celestron Schmidt-Cassegrain telescopes. #5125 **$29.95** (1.60)

Orion T-Adapter

Couple your 35mm camera to a Meade or Celestron Schmidt-Cassegrain. Use with T-ring to match your 35mm camera. #5116 **$29.95** (1.60)

Orion Off-Axis Guider Body

Use with any 1.25" Illuminated Reticle Eyepiece to accurately track a guide star during long exposure astrophotography. For Celestron or Meade Schmidt-Cassegrains. #5144 **$69.95** (1.79)

Orion Rich Field Adapter

Get four times brighter image and twice the field of view when used with 20mm-32mm 1.25" eyepieces. #5128 **$99** (2.09)

Telecompressor Lens

4 times the brightness and half the exposure time. Double your field of view. The Orion Telecompressor lens works with Meade and Celestron 8"-10"-11" Schmidt-Cassegrain telescopes. #5141 **$34.95** (1.60)

Extension Tube

Required for proper focus when using the Orion Telecompressor with an Off-Axis Guider. #5123 **$19.95** (1.60)

Serving Amateur Astronomers Worldwide Since 1975

New Retail Store in San Jose/ Cupertino area

10555 S.
DeAnza Blvd.
Cupertino, CA

America's Largest Telescope Dealer

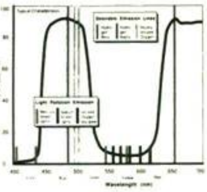
ORION TELESCOPE CENTER

421 Soquel Ave, Dept. R, P.O. Box 1158, Santa Cruz CA 95061

America's #1 Source for Telescopes and Binoculars

ORION
TELESCOPE CENTER

New! Orion SkyGlow™ Enhanced Light Pollution Filter



Most street lights emit light at a particular narrow wavelength. By blocking these wavelengths and passing the rest of the visible spectrum, contrast is dramatically improved. The Orion SkyGlow Filter allows maximum transmission of the important wavelengths of Hydrogen Alpha, Hydrogen Beta, and Doubly Ionized Oxygen—the light 'bands' most commonly emitted by Nebulas. It features better blocking of mercury vapor light and higher transmission at the critical Hydrogen Alpha and Hydrogen Beta frequencies than many competing models.

Designed for visual observing with any telescope, it threads into any standard 1.25" eyepiece. Includes handy storage case.

#5660 **$59** (1.60)

Orion Observer Series Eyepieces

Manufactured to strict tolerances. Chrome-plated brass barrels, fully coated, threaded for filters.

Orthoscopics 1.25" **$46.95** (1.60)
5mm #8471 9mm #8474
7mm #8472 12.5mm #8475

Kellners 1.25" **$28.95** (1.60)
18mm #8466 25mm #8467 40mm #8469

20mm Erfle1.25" #8485 **$59.95** (1.60)

Orthoscopics .965" **$39.95**(1.60)
5mm #8440 7mm #8442 9mm #8444
12.5mm #8446

Kellners .965" **$24.95** (1.60)
6mm #8450 9mm #8452 12mm #8454
18mm #8456 25mm #8458 40mm AH #8460

Fully Coated Barlow Lenses
1.25" 2x Barlow Lens #8744 **$39.95** (1.60)
.965" 2x Barlow Lens #8742 **$26.95** (1.60)

Precision Erecting Prisms
1.25" Erecting Prism #8757 **$39.95** (1.60)
.965" Erecting Prism #8756 **$35.95** (1.60)

New! Orion Moon Filter

Enjoy the moon's detail without spoiling your night vision. Our new Moon Filter will cut 87% of the light from the moon. Reduces glare of full or gibbous Moon by uniformly reducing light transmitted over the entire spectrum.

For 1.25" Eyepieces #5662 **$14.95** (0.95)
For .965" Eyepieces #5664 **$14.95** (0.95)

Astronomer's Flashlight

Made of unbreakable plastic. Has special night-vision red filter and a diffusion lens for even illumination. Includes belt clip, extra bulb.

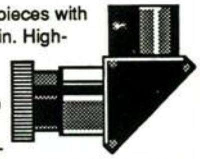
#5701**$8.95**(1.60)

Rubber Eyeguard

Soft rubber eyeguard stretches to fit most 1.25" eyepieces. Cuts off annoying ambient light and helps you position your eye at a comfortable distance from the eyepiece.

#7405 **$2.95** (.95)

2" Mirror Diagonal for Schmidt- Cassegrains



Now you can use 2" eyepieces with your Schmidt-Cassegrain. High-transmission first-surface mirror. Threads onto Celestron or Meade 4"-8"-10"-11" Schmidt-Cassegrains. A great diagonal at a great price.

#8767 **$89** (2.09)

Adapter for 1.25" eyepeices
Use 1.25" eyepiece in a 2" diagonal or 2" focuser.

#8768 **$12.95** (1.60)

Orion 2" Eyepieces

Excellent quality wide-field eyepieces. Experience an amazing field width of 65° with our new 2" 32mm Erfle eyepiece. Our 2" 50mm Plössl will amaze you with impressive views through your telescope at 44°! Both Orion 2" eyepieces are multi-coated for great contrast and clarity.

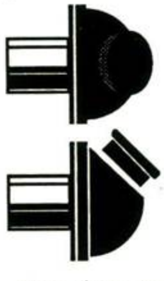
50mm Plössl #8490 **$89** (2.39)
32mm Erfle #8492 **$99** (2.39)

New ! 9mm Orthoscopic Illuminated Reticle Eyepiece

Our new improved illuminated reticle eyepiece is an excellent choice for astrophoto guiding or polar alignment. Self contained battery and illuminator eliminate cables and control boxes. Complete brightness control with the integral rheostat. The 4-element Orthoscopic design provides very sharp images. Barrel is internally blackened to reduce stray reflections.

#8488 **$109** (1.60)

45° Correcting Diagonal



Get correct images and convenient 45° angle viewing. Perfect for terrestrial use. Eliminates the need to crouch behind scope as with standard "straight-through" porro prisms.

#8765 **$56** (1.79)

Deluxe Metal-Clad Accessory Case

Keep your accessories safe and clean. Diced foam inserts can be tailored to your needs.
#5920 (16"x12"x6 1/2")
$49.95 (3.85)
#5921 (19 1/2"x12"x6 1/2")
$59.95 (4.95)

Observer's Chair

Perfect for all types of telescopic viewing. It has six adjustable height positions from 19" to 24" and a very comfortable padded swivel seat. The legs fold and the seat removes from the chrome-plated frame, for easy storage. Comfortable and very affordable. Try it!

#5935 **$39.95**(3.50)

Deluxe Eyepiece Case

Holds up to 10 eyepieces plus barlow. Die-cut foam insert. 8 1/2"x12 1/2"x3 1/8".

#5913 **$17.95** (1.95)

FREE CATALOG

56 Page 1987 Catalog
Huge selection of telescopes and accessories plus informative articles on astronomy, astrophotography, and more!

Call or Write today!

CALL TOLL-FREE
800-447-1001
In California:
800-443-1001

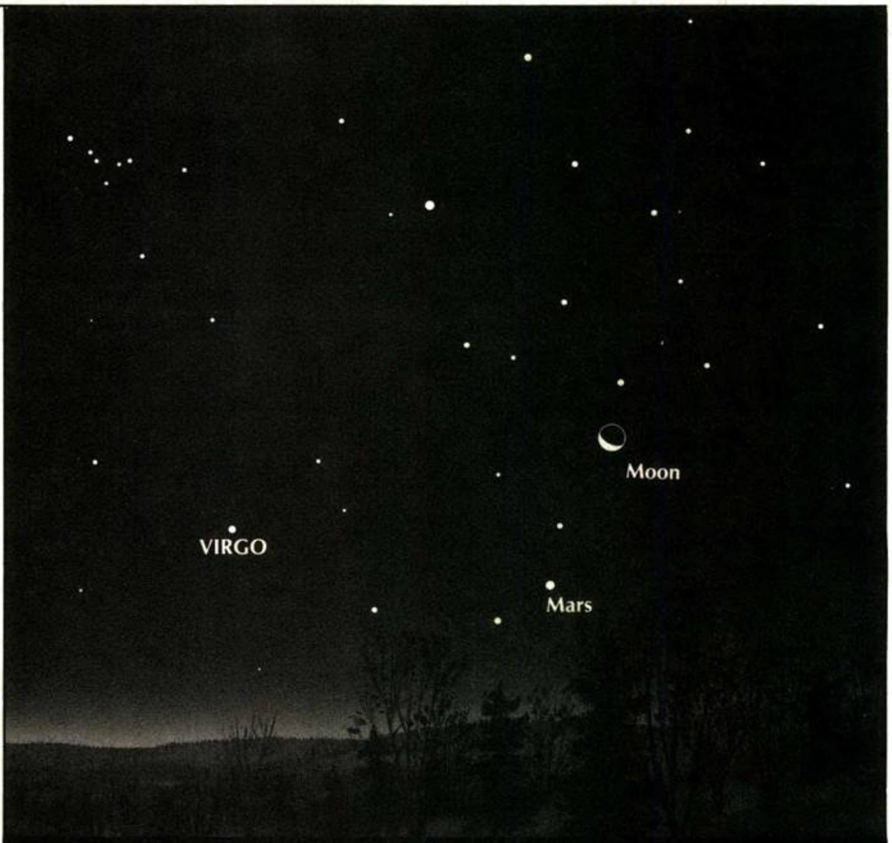
To Order: Just call our Toll-Free Number with your Visa or MasterCard, or send your order with personal check or money order. California residents add 6% sales tax.

Shipping charges to anywhere in the lower 48' States via UPS Ground or U.S. Mail are listed in (parenthesis) after each price. Additional charges apply to other areas or Air Shipment orders.

Eye on the Sky

Jupiter at Best Visibility

by Robert Burnham



Looking southeast, October 20, morning twilight

The Wanderers

Crisp October evenings are often filled with the tangy smell of burning leaves. The pleasant association of this smoky scent with starwatching is something amateur observers never forget. Looking up, you'll see only two planets in the dark, chilly sky. **Saturn**, which has faithfully tracked its stellar companion Antares across the southern horizon all summer, is now setting in the southwest. Because both Saturn and Antares are so low, you'll probably have to go to a park ballfield or a schoolyard where the trees and houses won't block your view.

Lying to the upper left of Antares in Scorpius, Saturn shines about half a magnitude brighter (magnitude 0.5) and looks perceptibly whiter than Antares. On the 24th, 25th, and 26th, the crescent Moon glides through the part of the sky Saturn and Antares occupy, which should make pretty configurations in the twilight on those evenings. (Antares is covered by the Moon for viewers in southern South America and southwestern Africa on the 25th.)

As Saturn dips into the trees, **Jupiter** rises into view in the east. Shining brilliant white at magnitude −2.9, Jupiter will probably startle people who otherwise seldom notice celestial objects. (Many UFO reports originate this way.) The dimness of Pisces, Jupiter's current "home" constellation, adds to the visual impact.

Jupiter is at opposition to the Sun on October 18, which means Jupiter rises at sunset, crosses the meridian at midnight (standard time, of course), and sets as morning begins. Coincidentally, Jupiter is also near perihelion — its closest approach to the Sun — which makes Jupiter brighter at opposition than it has been in the past twelve years.

In the last few evenings of October **Venus** appears very low in the west-southwest. It is slowly climbing away from the Sun — and thus higher in the sky — but won't be easily visible until the middle of next month. Venus is at magnitude −3.9 but appears dimmer because you are seeing it (if at all) in the brightest part of the twilight sky through thick atmosphere.

For information on viewing the Moon, planets, and deep-sky objects with telescopes, see **The Backyard Astronomer**.

October 4, the thirtieth anniversary of the *Sputnik 1* launch and the beginning of the space age, is also the date of greatest elongation for **Mercury**, but most likely only experienced planet watchers will see it during this apparition. Its current celestial position causes Mercury to set soon after the Sun, so its visibility is greatly diminished. Mercury is at magnitude 0.0 but lies less than 1° high in the southwest, forty-five minutes after sunset on the 4th. On the 28th, it passes between the Earth and Sun into the morning sky, where it can be seen much better next month.

At the end of the night as Jupiter sinks in the west, **Mars** climbs into view in the east. It is at magnitude 1.8 and moving eastward in Virgo toward the star Spica. (Mars passes the star in mid-November.) This month spotting Mars is like viewing Saturn: you need a site with a low, uncluttered view (eastward in this case).

At Full Moon on October 7, a **penumbral lunar eclipse** occurs as the Moon slips through the outer part of the Earth's shadow. But, although most of North America is turned toward the Moon, little will be seen even if skies are clear, because penumbral eclipses are notorious "nonevents." Only near maximum eclipse (12:02 a.m. EDT on the 7th or 9:02 p.m. PDT on the 6th) will a slight darkening be noticeable along the Moon's southern edge.

Opposite page: Using an 8mm f/2.8 fisheye lens and hypered Konica SR 400 film, Ernie Williams made this half-hour exposure of the Milky Way at Riverside. The red lights are observatories.

The **Orionid meteor shower** is well timed this year, because peak activity occurs in the wee hours of the 21st, when the Moon is New. The meteors, deriving from Halley's Comet, appear to radiate outward from Orion's club and are quite fast because they are approaching Earth nearly head-on. Many are relatively faint, though that's more unfortunate for astrophotographers than for naked-eye viewers. (Nevertheless, try to find a dark-sky observing site.) At peak you can expect to see about twenty-five meteors an hour.

The Starry Sky

While summer nights are often buggy and winter nights are always cold, autumn (and spring) offer the year's most comfortable starwatching. To appreciate what this season's skies have to show, however, you'll need to get away from city lights.

October Night Sky

Full Moon
October 7
12:12 a.m. EDT

Last Quarter
October 14
2:06 p.m. EDT

New Moon
October 22
1:28 p.m. EDT

First Quarter
October 29
12:10 p.m. EST

3rd The Moon is close to Earth for the first of two times this month at 9:36 p.m. EDT: 227,437 miles (366,025 kilometers).

4th Mercury is at greatest eastern elongation in the evening sky, but this apparition is very poor.

7th The Moon is Full at 12:12 a.m. EDT in Pisces and called the Harvest Moon. There is also a penumbral lunar eclipse (see text).

8th The Moon passes 4° north of Jupiter at 1 a.m. EDT.

14th The Moon is at Last Quarter at 2:06 p.m. EDT in Cancer.

15th The Moon is farthest from Earth at 5:23 p.m. EDT: 251,298 miles (404,425 kilometers).

18th Jupiter is at opposition in Pisces at magnitude −2.9; it is visible all night and crosses the meridian at midnight (1 a.m. daylight time).

20th The waning crescent Moon lies above Mars in the morning twilight (see diagram on page 58).

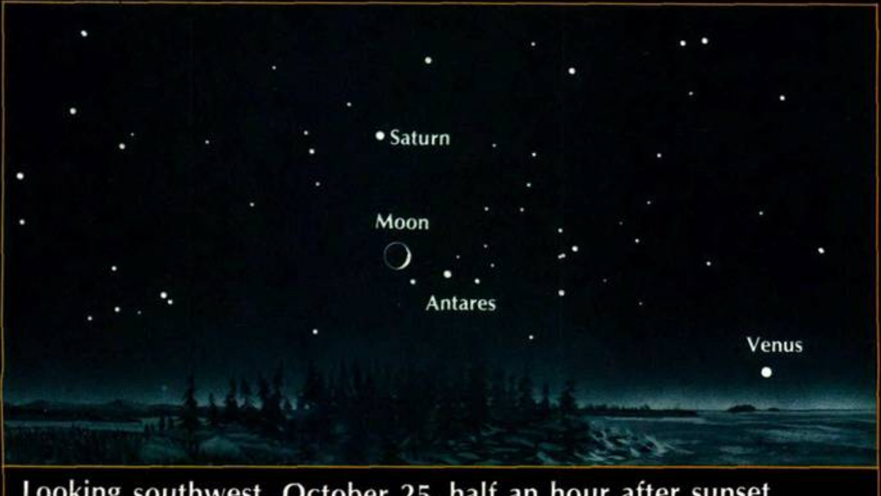
21st The Orionid meteor shower is at peak activity in the late hours tonight and the early morning hours tomorrow.

22nd The Moon is New at 1:28 p.m. EDT in Virgo.

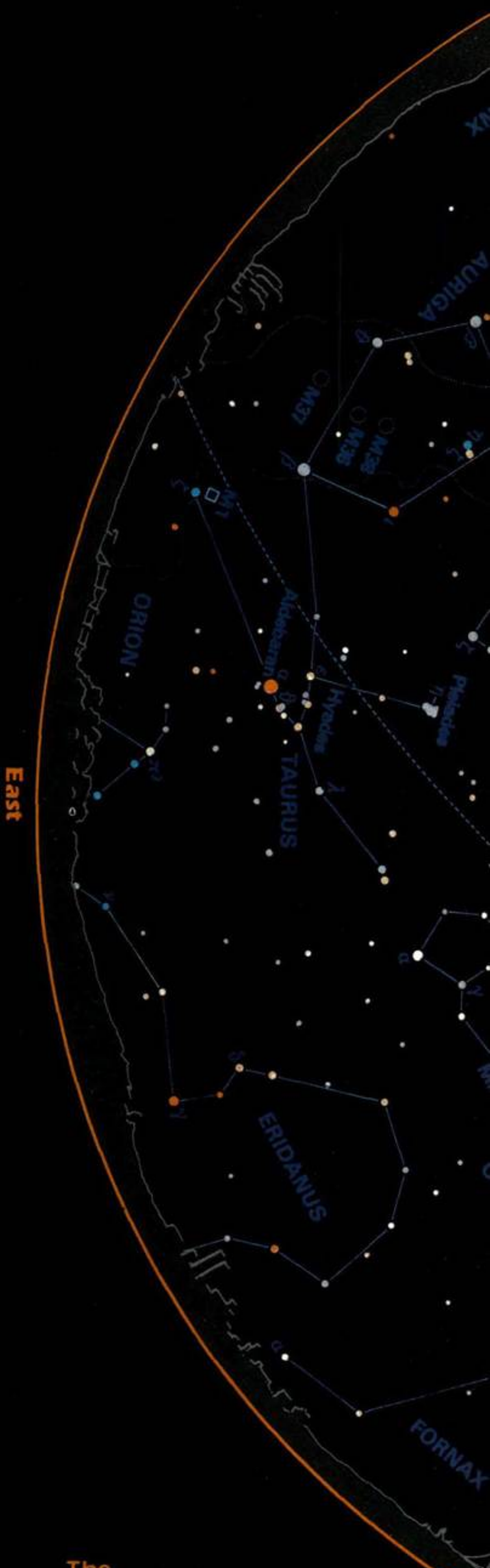
25th The waxing crescent Moon lies near Antares and below Saturn in the evening sky (see diagram below). Daylight savings time ends; set clocks back one hour.

28th Mercury is at inferior conjunction, passing between the Earth and Sun and moving into the morning sky. Look for it there before sunrise in about two weeks.

29th The Moon is at First Quarter at 12:10 p.m. EST in Capricornus. It also comes close to Earth for the second time this month at 10:38 p.m. EST: 229,964 miles (370,091 kilometers).

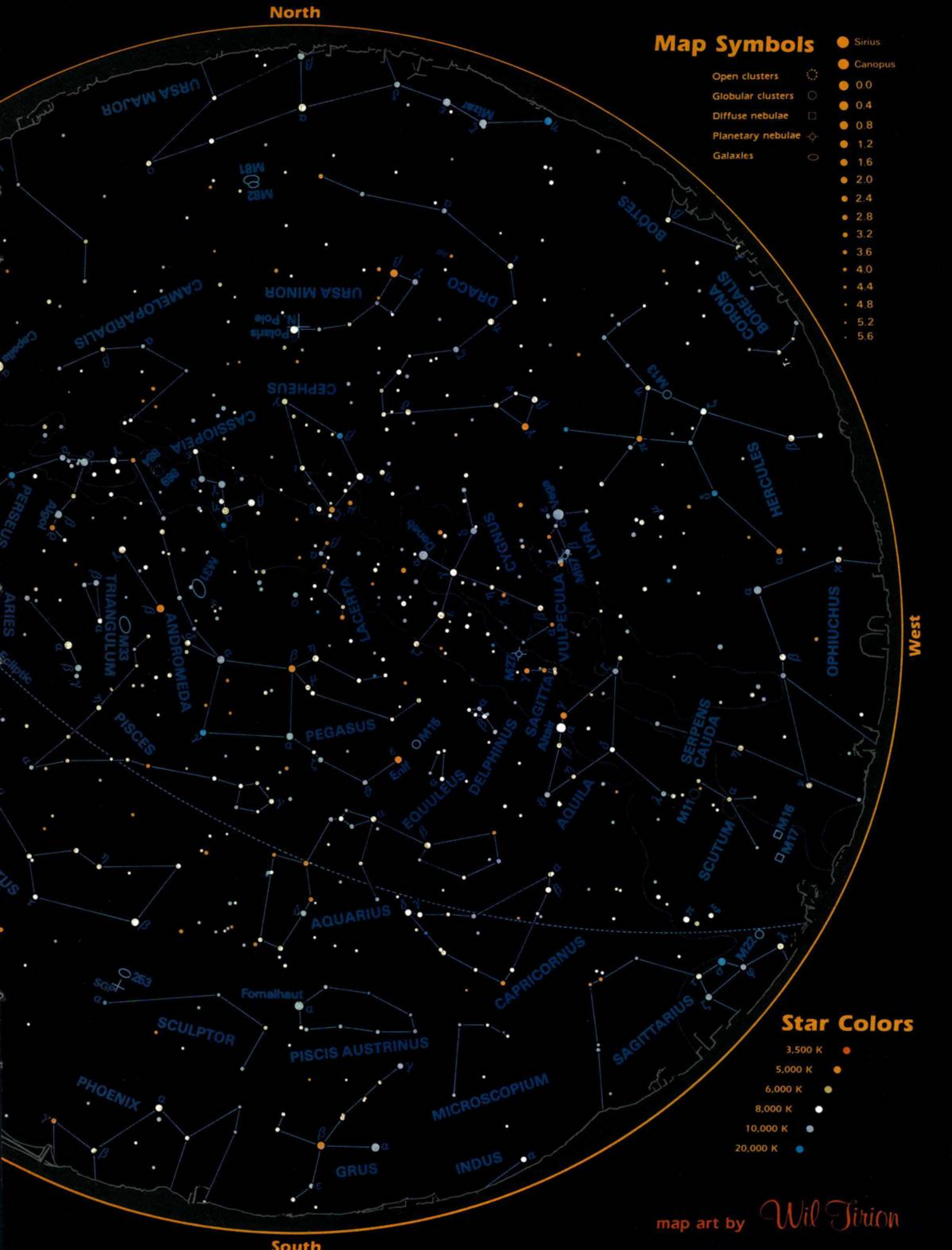


Looking southwest, October 25, half an hour after sunset



The
Star Dome
shows how the
sky looks at:

11:30 p.m. on October 1
10:30 p.m. on October 15
8:30 p.m. on October 31


North
Map Symbols
Open clusters
Globular clusters
Diffuse nebulae
Planetary nebulae
Galaxies
Sirius
Canopus
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
3.2
3.6
4.0
4.4
4.8
5.2
5.6
URSA MAJOR
Mizar
M81
M82
BOÖTES
URSA MINOR
DRACO
N. Pole
Polaris
CAMELOPARDALIS
Capella
CORONA BOREALIS
CEPHEUS
M13
CASSIOPEIA
884
869
PERSEUS
Algol
HERCULES
Deneb
CYGNUS
Vega
LYRA
M57
M31
TRIANGULUM
M33
ARIES
ANDROMEDA
LACERTA
VULPECULA
M27
OPHIUCHUS
West
Ecliptic
SAGITTA
PISCES
PEGASUS
M15
Altair
SERPENS CAUDA
Enif
EQUULEUS
DELPHINUS
AQUILA
M11
M16
M17
SCUTUM
AQUARIUS
M22
SGP
253
CAPRICORNUS
Fomalhaut
SCULPTOR
SAGITTARIUS
PISCIS AUSTRINUS
PHOENIX
MICROSCOPIUM
GRUS
INDUS
South
Star Colors
3,500 K
5,000 K
6,000 K
8,000 K
10,000 K
20,000 K

map art by Wil Tirion

SN 1987A

Star trail photo of supernova 1987A, taken March 26 with Ektachrome 64 film, a 50mm lens at f/1.4, and a 60-minute exposure. Photo by Francisco Bolivar Carneiro.

Gather a thermos of hot chocolate or coffee, a down jacket, your copy of ASTRONOMY, a red-lensed flashlight, and then drive about fifteen to twenty miles beyond the last of the streetlights.

Despite the **Milky Way** band that crosses the heavens roughly east to west, the sky will look dark when you first step out of the car. As your eyes dark-adapt you'll see more stars, but no one would ever call autumn's constellations breathtakingly prominent!

Let's begin by facing west. Three bright stars form a scalene triangle resting on its longest side. At the left-hand tip is Altair, part of **Aquila** the Eagle. The right-hand corner is Vega in **Lyra** the Lyre. More or less above Vega is Deneb in **Cygnus** the Swan. Lyra is small but easy to make out once you identify Vega. Cygnus begins at Deneb and extends down to form a cross. Aquila is more difficult, but after you locate the diamond shape of its outspread wings, Aquila's long tail is simple to see. Altair, Vega, and Deneb are 1st-magnitude stars and together make up the "Summer Triangle," an asterism that lies high in the south during August and September evenings.

To the right of Vega is the head of **Draco** the Dragon, a sinuous figure that wraps itself in a jagged curve halfway around the pole star, Polaris. **Ursa Minor** the Lesser Bear is also known as the Little Dipper; it swings from Polaris, the star at the end of its handle. (The Big Dipper, **Ursa Major**, is down in the trees below Polaris.)

If you draw a line from Vega past Altair, you'll reach **Capricornus** the Sea Goat, one of the twelve constellations of the zodiac. Capricornus is a wide "V" made of 3rd-magnitude and dimmer stars; it is hard to see from the city. To the upper left of Capricornus lies another member of the zodiac, **Aquarius** the Water-Carrier. Aquarius is harder to trace, because it lacks Capricornus' symmetrical pattern. Use the star map and take your time.

A solitary bright star stands below Aquarius: Fomalhaut in **Piscis Austrinus** the Southern Fish. **Cetus** the Whale lies to the left of Aquarius; its star pattern is fairly easy to follow. Above Aquarius and Cetus prances **Pegasus** the Flying Horse, recognizable by the four stars marking its Great Square. The horse is upside down — the Square forms the horse's wings, while its neck arches down to Aquarius and its forelegs reach up toward Cygnus.

Bright Jupiter is the guide to **Pisces** the Fishes (see Skylore). The western fish is a rough circle of stars below the Square; the eastern fish zigzags to the left of it. The fishes' tails are tied by a cord knotted at the star Alpha (α), called Alrisha.

From the Square's upper left corner two lines of stars run eastward to mark **Andromeda** the Chained Princess, while **Triangulum** the Triangle and zodiacal **Aries** the Ram nestle nearby. Andromeda is reaching toward her rescuer **Perseus** and her mother, Queen **Cassiopeia**. (Her father, King **Cepheus**, stands above Polaris.)

Low in the east, two grand harbingers of winter — the Pleiades and Hyades star clusters — are chasing the autumn constellations offstage. Both clusters belong to **Taurus** the Bull, a figure still mostly hidden in the trees but dominant in the eastern sky a month from now.

Skylore

Jupiter's bright opposition in Pisces this month lends a touch of sparkle to a constellation that lacks it. Like several others in the zodiac, Pisces is unremarkable by itself. If the constellation didn't happen to lie across the Sun's apparent path among the stars, few people would pay any attention to it at all.

Pisces is the constellation in which the Sun crosses the celestial equator into the Northern Hemisphere on or about March 21 — the vernal equinox. Traditional usage calls this place "the First Point of Aries," but the phrase is archaic because the vernal equinox slipped out of Aries roughly two thousand years ago. Precession, a long gyration of the Earth's axis, induces a glacially slow change in all celestial coordinates and is driving the vernal equinox steadily westward in the sky. (Once in Aries, now in Pisces; Aquarius is next, though at the pace things are going, several centuries will pass before the "Aquarian age" dawns.)

But why should anyone see fish here? The autumn sky is generally called the Water or the Sea, because most of its figures have some aquatic relation. Hence you see Cetus the Whale, Aquarius the Water-Carrier, Capricornus the Sea Goat, and so on. But several thousand years ago, when the constellations were first formed, these patterns held prominent places in the night sky during the rainy season.

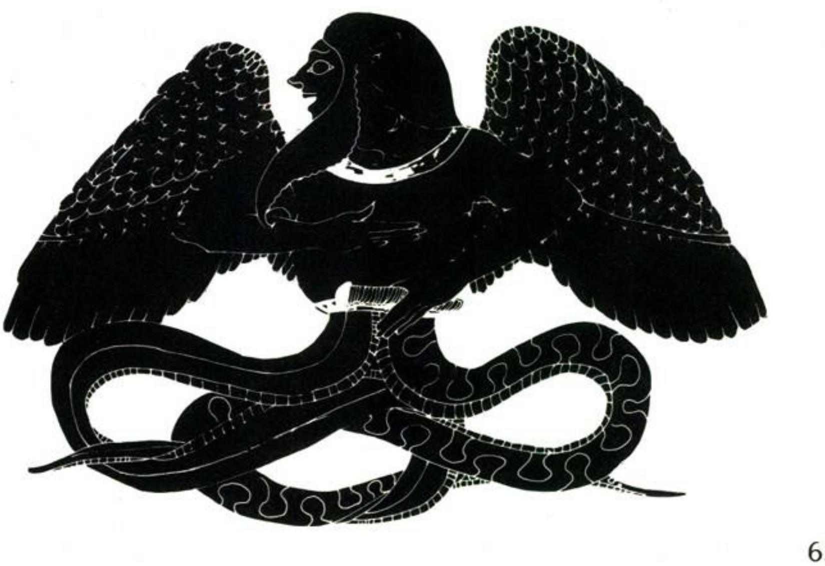
In Mesopotamian mythology our Pisces was only one fish, though its exact depiction has been lost over the centuries. The second fish may have been added later when the astronomer-astrologers of Babylon realized their calendar needed an extra month every six years to keep it in step with the Sun. In any case, by the time of the Greeks the constellation had taken on today's form.

In Greek mythology the Fishes were said to be Aphrodite and her troublemaking brat Eros. The story goes that after the Olympian gods defeated the half-human race of Giants (see last month's Skylore), Geia — who was Mother Earth and also mother of the Giants — bore a monstrous son called Typhon. When he stood erect, his head scraped the clouds, and his lower legs were serpents. Typhon's arms, which could reach hundreds of miles, had snake-heads instead of hands. His eyes glowed with fire and his breath belched melted rocks and smoke.

When Mother Geia sent him against Olympus, the gods scattered as fast as they could. Eventually they wound up in Egypt, where they took on the shape of animals so they could pass unseen. Zeus, for example, became a ram, Artemis a cat, and Aphrodite a fish. When Typhon approached, Aphrodite snatched her son Eros, changed him into a fish too, and together they leapt into the clouded, muddy waters of the Nile. So Aphrodite wouldn't lose track of him, the story says she tied her tail to his with a silken cord.

And Typhon? Alone among the Olympians Athene stood firm and loudly proclaimed Zeus a coward. Shamed into action, he wounded Typhon with a bolt of lightning. Then, regaining his chariot, thunderbolt-hurling Zeus pursued Typhon all the way to Sicily, where he finally pinned the monster, screaming with rage, by dropping Mount Etna onto him.

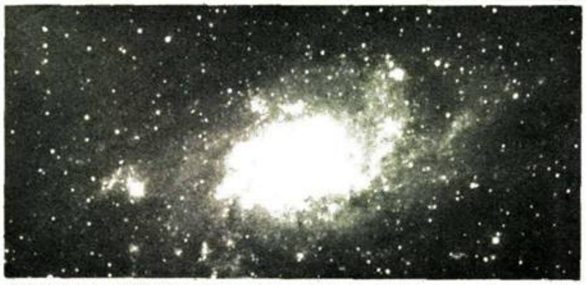
If you visit Sicily today, the plume of smoke from Etna's summit tells you that for Typhon, at least, the last word has yet to be said.



Meade & Celestron
LUMICON Carries a full line of telescopes & accessories. Fast Delivery, competitive prices. Both Catalogues $3.

LUMICON FOR HIGH PERFORMANCE

ASTROPHOTO OF THE MONTH



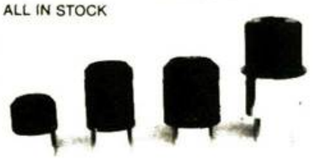
Spiral Galaxy M-33 in Triangulum. This low surface brightness galaxy is seen best visually with a LUMICON DEEP-SKY Filter. Photo by Dr. Jack Marling using a LUMICON Newtonian EASY-GUIDER and 2415 film sensitized in a LUMICON Model 300 HYPER-KIT; 40 min. exposure, 10"f/5 telescope.

20mm NAGLER

Also new 12mm & 16mm NAGLERS

TELE VUE™ EYEPIECES USE THE BEST!!

ALL IN STOCK



Renaissance 4" f/5.5. Telescope	$1395
7.4, 10.4, 13, 17, 21, 26mm Plossl, 50°	$89
1.8X or 2.5X Tele Vue Barlow Lens	$89
32mm Plossl, widest true field in 1¼"	$109
55mm 2" Plossl, widest possible field	$190
15mm Wide-Field, 1¼" eyepiece, 65°	$129
19mm Wide-Field, 1¼" eyepiece, 85°	$139
24mm Wide-Field, "superb," 65°	$159
32mm Wide-Field, 2" eyepiece, 65°	$229
40mm Wide-Field, "awesome," 65°	$289
4.8mm Nagler, 82° field	$149
7mm Nagler, 1¼" eyepiece, 82° field	$185
9mm Nagler, 82° field, "the best"	$219
11mm Nagler, 82° field, 1¼" or 2"	$235
13mm Nagler, 82° field, 1¼" or 2"	$249
12mm Nagler, type II, 82°, 1¼"/2"	$249
16mm Nagler, Type II, 82°, 1¼"/2"	$299
20mm Nagler, Type II, 82°, 2" only	$340

ADJUSTABLE PIGGYBACK MOUNT

The LUMICON adjustable piggyback mount is ideal for telescopes of 6-16" aperture. It permits **both** vertical and sideways adjustment for optical alignment. Also ideal to mount LUMICON 80mm SUPER-FINDER™, large telephoto lenses and small telescopes up to about 5 lbs.
LUMICON Adjust. Piggyback Mount .. **$45**
Specify telescope size: 6", 8", 10", 11", 14", 16"

H-ALPHA PASS FILTER

Yields spectacular contrast gains in B&W photography with telephoto lenses. Yields pinpoint star images. Superb with hypered 2415. For color, use the Minus Violet (MV) Filter.

Specify Lens Size	**H-Alpha**	**(MV)**
46, 48, 49mm	$35.00	$29.00
52, 55, 58, 62mm	$45.00	$35.00
67, 72, 77mm	$52.00	$45.00
82mm	$55.00	

Hypered 2415 film, 36 exp . . . $10.95 . . . 3/$29

NEW! ENHANCED SILVER DIAGONAL MIRRORS BOOST TELESCOPE PERFORMANCE

LUMICON 1.3" & 2.1" enhanced silver diagonal mirrors & 1¼" star diagonal.
The new LUMICON diagonal mirrors have a special enhanced silver coating with a protective overcoating for long life. Visible reflectivity is 98-99% compared to 86-89% for standard aluminum coated mirrors. The extra 10-12% transmission is like adding an inch of aperture! The substrate is fine annealed Pyrex flat to 1/8 wave.

1.32" **$29.95** 1.52" **$34.50** 1.83" **$39.50**
2.14" **$49.50** 2.60" **$65.00** 3.10" **$89.50**
4.25" **$149.50**

ENHANCED SILVER STAR DIAGONAL

90° star diagonals with above enhanced silver *mirrors in a CNC machined black anodized* aluminum body. Performance far exceeds prism diagonals.

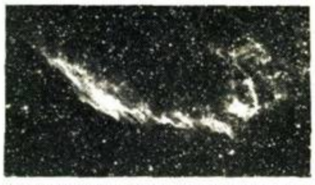
1¼" (1.32" mirror)	$89.50
2" (1.83" mirror)(see photo above)	$145.00

LUMICON FILTERS STOP LIGHT POLLUTION

UHC Filter™

ULTRA HIGH CONTRAST

The **LUMICON UHC FILTER** is specially designed for visual astronomy in areas of severe light pollution or for viewing very faint nebulae at any location. **UHC** stands for **U**ltra **H**igh **C**ontrast and this filter is guaranteed to yield a higher visual contrast on planetary and emission nebulae than any other filter at any price. 24nm visible bandpass, 482-506nm. Transmission = 85-95%.



"I CAN SEE THE VEIL NEBULA!"
Rich Zepernick saw the Veil Nebula for the very first time with a LUMICON UHC Filter. He stated, *"It was actually there! and not just around 52 Cygni, but the whole loop! Words cannot possibly express my feelings. I don't know how I managed without these filters."*
Zepernick, Cresskill, NJ

For optimum astronomy, use either the **LUMICON DEEP-SKY Filter** or the **LUMICON UHC Filter**

DEEP-SKY FILTER™

The **LUMICON DEEP-SKY FILTER** improves your view of **all** deep-sky objects including galaxies and comets. It removes natural and man-made light pollution and yields 3-6x contrast gain for nebulae and 1-3x contrast gain for clusters and galaxies. It is ideal for **both** visual use and B&W or color photography. This gentle filter yields the most natural view of any LPR filter available today. 90nm visible bandpass, 442-532nm. H-Alpha 656nm transmission = 85-95%. Visible transmission = 90-95%.

	Standard	**Premium***
0.96" LUMICON DEEP-SKY Filter threads into most 0.96" eyepieces		$59.50
1¼" *LUMICON DEEP-SKY Filter* *threads into most 1¼" eyepieces*		*$79.50*
48mm LUMICON DEEP-SKY Filter (1.75" aperture), threads into most 2" eyepieces. Also fits LUMICON EASY-GUIDERS		$119.50
2" LUMICON DEEP-SKY Filter (1.5" aperture), threads into most 2" eyepieces. Also has male & female camera T-threads for prime focus photography	$99.50	$119.50
72mm LUMICON Giant DEEP-SKY Filter (62, 67, 77mm adapter, $8)		$299.50
1¼" LUMICON UHC Filter threads into most 1¼" eyepieces	$79.50	$99.50
48mm LUMICON UHC Filter (1.75" aperture) fits most 2" eyepieces	$159.50	$199.50
Set of Both 1¼" **DEEP-SKY** and **UHC Filters** (Save 11%)		$159.50
LUMICON H-BETA Line Filter (9mm bandpass at 486nm). For the California Nebula, Horsehead Nebula, and other extremely faint nebulae.	1¼" $89.50	48mm $189.50
Oxygen-III Filter for very faint planetary and diffuse nebulae, 11nm bandpass at 496nm and 501nm 0-III lines	1¼" $99.50,	48mm $199.50
Telephoto lens adapter for 2" or 48mm filter. Select 46, 49, 52, 55, 58mm		$6.95
Universal adapter for 1¼" filters. Adapts the 1¼" filters to any 1¼" eyepiece		$16.00
Universal adapter for 48mm or 2" filters. Allows use of any 1¼" eyepiece		$20.00

**Premium filters are selected best of the lot and typically have 5-10% higher transmission. Not always available. Include individually measured transmission data.*

DEEP-SKY ASTROPHOTOGRAPHY

FILM HYPERSENSITIZATION KITS†

LUMICON HYPER-KITS™ yield 3-15X film speed gain in long exposures. They are safe & simple to use. Easy HYPER-KIT includes a chamber with all controls and fittings, thermometer, a refillable cylinder of nonflammable forming gas & hand-operated vacuum pump.
U.S. Patent 4,473,636

MAKE YOUR OWN HYPERED FILM

MODEL 300 HYPER-KIT sensitizes any 35mm film in hours. Best for 2415. Achieves highest possible film speeds **$295.00**

MODEL 600 HYPER-KIT [See Photo] Like the Model 300, but also sensitizes 120/220 larger format film and small glass plates **$350.00**

MODEL 1200 HYPER-KIT is for 4X5" plates and film up to 5X7". Has 2 gas cylinders and includes temperature controller .. **$595.00**

Temperature controller for any HYPER-KIT **$59.50**

Electric Vacuum Pump, Model R-10 **$280.00**

GUIDE OFF-AXIS FOR LOVELY ASTROPHOTOS

All **LUMICON EASY-GUIDER™** off-axis guiders† have both radial and 360° rotational adjustments for 5X eaiser guide-star selection, use 48mm filters, 360° camera rotation, large prisms fo bright guide-starts. *Specify Camera and Telescope type.*
U.S. Patent # 4,448,500

NEWTONIAN EASY-GUIDER™

Full aperature. Installs in secs. Specify 2" or 1¼".

NEWTONIAN EASY-GUIDER	$169.50
3X Relay Diagonal (see photo)	$79.50
Illuminated reticle eyepiece system	$89.50

Guider for Hasselblad **$350,** Mamiya 645 **$199**

CASSEGRAIN EASY-GUIDER™

For C-8, Meade 2080, Dynamax-8. Includes 50mm achromatic lens for f/5.8 operation-3X shorter exposures! **Superb rich field viewing, too!**

CASSEGRAIN EASY-GUIDER **$225.00**
Adapter for Hasselblad **$185,** Mamiya 645 **$159**

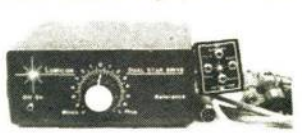
GIANT EASY-GUIDER™

For Celestron-11, C-14, and the 10" Meade 2120. Includes 80mm clear aperture achromatic lens for edge-to-edge illumination & pin-point star images. F-ratio adjustable f/4-f/11. **Also yields unmatched Rich-Field viewing.**

GIANT EASY-GUIDER **$395.00**
48mm DEEP-SKY Filter ordered with any EASY-GUIDER (SAVE $20) ...... **add $99.95**
Adapter for Hasselblad **$195,** Mamiya 645 **$96**

WHAT DO YOU NEED?

1. Illuminated reticle eyepiece **$89.50**
Lumicon 12mm eyepiece system has adjustable L.E.D. illumination, dual crosslines, battery pack.
2. Cable release for long exposures .. **$9.95**



3. **LUMICON Quartz Drive Corrector** **$219**
Dual-axis drive corrector is essential for astrophotography and/or field use of your telescope. 40Hz/80Hz variable output controls telescope drive. 60Hz Quartz reference ± 12VDC *Declination control output.* Both 110VAC and 12VDC input for home or field use. Declination reverse switch for Newtonians.
Declination motor (state telescope) .. **$70**
NEW Deluxe Digital Qtz. Drive Correc. **$298**

HYPERSENSITIZED FILM

LUMICON Hypersensitized film is essential for good deep-sky astrophotography. Deduct 10% for 3 or more rolls (mixed o.k.).

Film Type, 35mm	**Exposures**	**Price**
2415, Ultra-fine B&W, red sens.	36	$10.95
SR1600, fastest of all, color neg	24	$12.95
Konica SR200, fine grain color neg	12	$9.95
3M 1000, fastest slide film	20	$12.95
Fujichrome RD100, fine grain slide	24	$12.95
5072, color slides from neg	36	$6.95
D-19 B&W Developer	1 gal.	$6.95

LUMICON®

2111 Research Dr. #5A, Livermore, CA 94550
For phone orders please call (415) 447-9570
LUMICON Products catalogue $2.
Foreign orders add 6% ($8 minimum)
California Residents add 6% tax.
Prices subject to change w/o notice
Hrs: M-F 9am - 5pm; Sat 11am - 3pm

NEW LUMICON® PRODUCTS

LUMICON, 2111 Research Dr., #5
Livermore, CA 94550 (415) 447-9570

NEW! NON-ROTATING HELICAL FOCUSER

LUMICON® DELUXE NON-ROTATING HELICAL FOCUSER on a 6" telescope.

LUMICON has just designed a deluxe smooth helical focuser with non-rotating 2" i.d. eyepiece holder. It has a vertical travel of 1¼" and a very low profile only 1½" high. It is CNC machined, black anodized, and a perfect match to LUMICON EASY-GUIDERS.

Select your desired base-plate shape!
Flat, 7" OD, 9½" OD, 12½" OD, 16" OD, 20" OD, SUPER-FINDER base plate.

LUMICON Deluxe Helical Focuser	**$79.50**
3 handles (see photo)	**$12.95**
Helical focuser with 3 handles	**$92.40**
2"/1¼" adapter w/48mm filter threads	**$20.00**
2" LUMICON EASY-GUIDER	**$169.50**

EYEPIECE PROJECTION

These adapters allow high magnification photography of the Moon and Planets using eyepiece projection. They may be used without any eyepiece for prime-focus photography. All adapters use standard camera T-rings.

Tele-Extender for Meade or Celestron SCT.	**$32**
1¼" Basic Camera adapter, 2 part system	**$32**
0.96" Basic Camera adapter, 2 part system	**$32**
1¼" prime Focus adapter, fits 1¼" focuser	**$22**
0.96" prime Focus adapter, fits 0.96" focuser	**$22**
Camera T-ring, specify 35mm camera type	**$12**

LUMICON 50mm, 80mm SUPER-FINDER™

Visual Astronomers prefer the LUMICON 80mm SUPER-FINDER™, since hundreds of deep-sky objects, including most Messier objects, are visible directly. SUPER-FINDERS also make nice small portable telescopes. 80mm aperture, F=300mm coated achromat. The deluxe SUPER-FINDER uses an 80mm, F=500mm air spaced achromat.

1¼" 50mm Finderscope **$59.50**, right-angle	**$89.50**
1¼" straight-thru 80mm SUPER-FINDER	**$169**
1¼" right-angle version, w/star diagonal	**$195**
2" right-angle version, non-rotating focuser	**$199**
1¼" Deluxe right-angle Super-Finder*	**$279**
2" Deluxe right-angle Super-Finder*	**$309**
25mm Cross-hair 1¼" eyepiece (12X)	**$29**
*1¼" Star Diag. **$32**, 2" Star Diag., silver,	**$145**
1¼" Amici Prism diag. for correct left-right views	**$59.50**

2" ADAPTERS MEADE, CELESTRON TELESCOPES

These adapters convert refractors and Schmidt-Cassegrain telescopes for 2" operation. They allow use of 2" accessories, such as the LUMICON 2" EASY-GUIDER for photography. They also allow use of 2" eyepieces and/or 2" star diagonal for viewing.

2" adapter for C-8, Meade 2080, etc.	**$26.00**
2" adapter for Criterion 4000, 8000	**$26.00**
2" adapter for C-80, C-90, C-100	**$39.50**
2" adapter for C-70, C-80F, C-90F, C-100F	**$39.50**
2" Accessory adapter for Comet Catcher*, C-6*, Meade 310, 320 refractor	**$30.00**
2" adapter for Takahashi E-130, 160	**$59.50**

ASTRONOMER'S LED FLASHLIGHT

Two flashlights in one! A red LED (light emitting diode) is ideal to read star maps and preserves your eye's dark adaption. A brighter green LED help you to find things in the dark. No bulb to burn out, 3 AA batteries last many months.

Starlight™ LED Flashlight **$14.95**

VIEWING ADAPTERS

2"/1¼" Adapter, threaded 48mm filters	**$20**
2"/1¼" Adapter, unthreaded	**$12**
2"/T - Thread adapter, threaded 48mm	**$25**
T - Thread/1¼" adapter. Converts telephoto lenses for viewing as finderscopes	**$25**

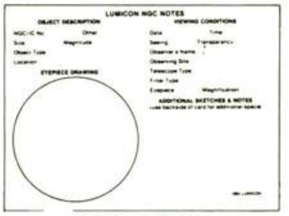
EXTENSION TUBES

1.0" long Thread-in extension tube	**$12.00**
1-2½" long, threaded for 1¼" filters	**$16.00**
4½" long extension tube, 1¼" i.d.	**$25.00**
2" i.d. Extension tube, 3" long, threaded for 48mm filters, adds 1.6-3.0"	**$26.00**

48mm COLORED GLASS FILTERS

These 48mm Filters thread into LUMICON EASY-GUIDERS and most 2" eyepieces. Use adapter for 1¼" eyepieces. AR Coated.

Filter:	Bandpass	Trans	Price
Ultraviolet	320-420nm	85%	**$35**
Minus Violet	420nm-IR	96%	**$29**
Blue Tricolor	340-470nm	80%	**$35**
Hi Perf. Blue	300-540nm	95%	**$35**
Yellow	480nm-IR	98%	**$18**
Green	490-590nm	60%	**$18**
Orange	560nm-IR	98%	**$18**
Red	600nm-IR	98%	**$18**
H-Alpha Pass	640nm-IR	95%	**$35**
Cyan	340-580nm	95%	**$59**


LUMICON NGC NOTES
OBJECT DESCRIPTION
VIEWING CONDITIONS
EYEPIECE DRAWING
ADDITIONAL SKETCHES & NOTES

NGC NOTES

These handy **NGC NOTES** are stiff 4"X5½" cards. the **NGC NOTES** fit in your hand and are ideal for making notes and sketches while observing at the eyepiece. Making sketches **greatly improves** your observing skills and also gives you a permanent record. Get 200 **NGC NOTES** for Messier objects; NGC object observers should get 400-800 **NGC NOTES.**

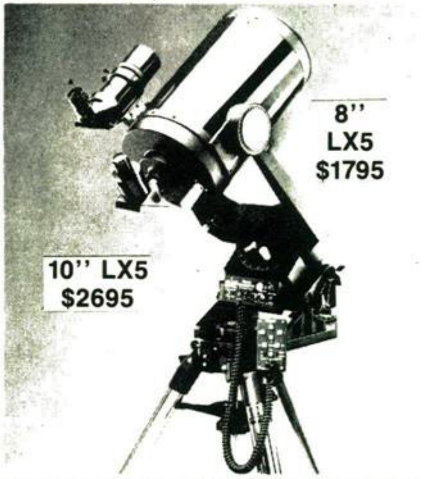
NGC NOTES, Pack of 200 .... **$9.95**
Pack of 400 **$17.95** Pack of 800 **$32.95**

Meade® TELESCOPES AT LUMICON

NEW! MEADE 2080/LX5 ..... $1795
MEADE 2120/LX5 .... $2695

The most advanced Schmidt-Cassegrain telescope available! *Standard equipment* includes dual-axis hand-held electronic command center, 2" mirror star diagonal, 9X60mm polar viewfinder, multi-coated/enhanced optics, 26mm Super Plossl, tripod and wedge.

#39 Electric declination for 2080 or 2120/LX5	**$109**
Dew shield-essential 8" (#712) **$65**; 10" (#710)	**$98**
Accessory shelf for field tripod ($40 list)	**$28**
LUMICON EASY-GUIDER/Rich-Field viewer: for 2080 (f/6 operation) **$225**; for 2120 (f/4-f/10 operation)	**$395**
Computer control system, 8000 object memory	**$1495**



Meade 8" Model 2080/LX5: Shown with *standard-equipment* 9X60mm finder, dual-axis controller, 2" Diagonal Mirror, Equatorial Wedge, Field Tripod.

10" Meade 2120/GEM ONLY $1799

Meade 2120/GEM (left) and 8" 2080/GEM Schmidt-Cassegrain optics on German Equatorial Mount.

2080/GEM, 8" f/10 w/MCSO, equatorial mount	**$998**
2120/GEM, 10" f/10 w/equatorial mount	**$1799**
2120/GEM, 10" f/10 w/MCSO, equatorial mount	**$1949**
Dew shield & accessory tray, 8" **$72;** 10"	**$144**
#784 Motor & quartz drive corrector ($310 list)	**$219**
Computer Control system, 8000 object memory	**$1495**
Solar Filter for 2080 ... **$149;** for 2120 ...	**$185**

4" MEADE 2045 w/table tripod $595

4" f/10 Meade 2045/LX3 w/quartz drive	**$795**
#36 dual-axis cont. (LX3) **$99,** #38 dec. motor	**$99**
Wedge & field tripod for Meade 2045 ($380 list)	**$298**
Dew shield ($80 list) .. **$55;** Solar Filter ..	**$95**

FILTERS STOP POLLUTION

LUMICON UHC Filter for nebulae. Standard 1¼"	**$79**
Prem 1¼" **$99;** Std 48mm **$159.50;** Prem 48mm	**$199.50**
LUMICON Deep-Sky Filter, 1¼" Premium	**$79**
48mm Prem Deep-Sky **$119.50, $99.95** w/Easy-Guider	
Adapter for viewing w/1¼" eyepiece	**$20**

PHOTOGRAPHY ACCESSORIES

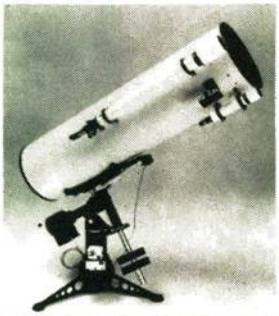
LUMICON Newtonian Easy-Guider, 1¼" or 2"	**$169**
LUMICON Cassegrain EASY-GUIDER for Meade 2045, 2080/LX5 and 2080/GEM (state camera)	**$225**
Illuminated reticle eyepiece & battery pack	**$89.50**
Dual-axis Drive corrector	**$219**

These Meade Telescopes are complete and ready for viewing.

They include telescope with all coated optics for high transmission, mount, tripod or pier with legs, motor drive (except models 6600, 8800, GEM series). Finderscope, at least one eyepiece, and complete instructions. Call or write LUMICON for full technical information. MCSO means multi-coated silvered optics.

MEADE NEWTONIAN TELESCOPES

16" f/4.5
MEADE
DS-16A
only
$1975



Note: Astrophotographers should order optional sealmaster ball bearings for the DS-16A (add $229).

Model 6600, 6" f/5 w/1¼" focuser, 6X30 finder	**$685**
Model 628c, 6" f/8 w/motor, 2" focuser, 8X50 finder	**$798**
Model 645c, 6" f/5 w/motor, 2" focuser, 8X50 finder	**$829**
Model 8800, 8" f/4.5 w/1¼" focuser, 6X30 finder	**$895**
Model 826c, 8" f/6 w/motor, 2" focuser, 8X50 finder	**$975**
Model DS-10A, 10" f/4.5 w/motor, 2" focuser	**$995**
Model DS-16A, 16" f/4.5 w/motor, 2" focuser	**$1975**
Sealmaster ball bearings for DS-16A, recommended!	**add $229**
Finderscope for DS-10A, DS-16A, 8X50mm right angle	**$126**

All foreign orders add 6% ($8 minimum). California residents add 6% tax. Prices subject to change w/o notice. Set Meade and LUMICON Catalogues $4. **LUMICON, 2111 Research Dr., #5, Livermore, CA 94550.** Call **(415) 447-9570** for information & orders. Store Hours: M-F 9am-5pm; Sat 11am-3pm. All telescopes shipped F.O.B. Livermore.

The Refractor Advantage: Quality over Size

by Alan Dyer

Refractors are fashionable once again. Like wide lapels, miniskirts, and narrow ties, if you wait long enough, everything comes back into fashion. For decades the refractor was considered the last choice for the serious amateur astronomer, but with the wider range of high-quality refractors now on the market, that attitude is changing fast.

Some observers have had bad experiences with refractors. The typical 60mm "department store" variety — with poor eyepieces, small light-gathering power, and wobbly mount — has turned off legions of people to astronomy, people who expected too much from their "powerful" telescope.

Another factor in the refractor's fall from grace was the misconception proclaimed in many astronomy handbooks that "serious" observing (whatever that meant) required at least a 6-inch telescope. Well, who could afford a 4-inch refractor, let alone a 6-inch? And even if money was no object, how would you transport such a beast? Spending thousands of dollars on a small-aperture refractor, when for the same money you could get a 20-inch reflector, just didn't make any sense.

And if these factors were not enough to ruin the refractor's reputation, refractors also produced images with annoying colored halos. Even though refractor images were a little sharper than those produced by reflectors, most amateur astronomers thought the difference could only be noticed by dedicated planetary observers. By the late 1970s most observers were primarily interested in deep-sky observing, which strengthened the belief that a bigger telescope meant a better telescope. Thus, the reflector came to dominate the world of amateur astronomy.

Interest in the refractor declined in the 1970s and early 1980s as amateurs bought more and more "light-buckets." Large Dobsonian scopes provided the type of deep-sky views amateurs had only dreamed about a few years earlier. But while these behemoths lumbered through the astronomy world, the refractor began to make a comeback, re-emerging from the undergrowth of misconception and myth surrounding optics. Serious observers were again considering the refractor worthy of their attention.

Why the change? Some good oppositions of Mars — one in 1986 and an even better one coming in 1988 — are reviving interest in planetary observing. But there's more to it than that. People are learning what telescopes can and cannot do. Amateur astronomers have recovered from aperture fever and are now looking for quality as well as quantity. They're looking for the best telescope, and the best isn't necessarily the biggest.

Inch for inch, refractors can outperform any other type of telescope, if you bear one critical factor in mind — the scope has to be made well. All refractors are not created equal.

Why Refractors Perform

There are several reasons well-crafted refractors perform better than reflectors and catadioptrics. The most significant is the refractor's generally superior optical quality. Because most high-quality refractors are limited production models, their optics are usually individually crafted. Plus, a refractor has relatively simple lenses: there are no complex corrector plates or aspheric mirrors to grind. With straightforward optics and wider tolerances, state-of-the-art refractors can be manufactured with less effort than comparable reflectors. (The process is by no means easy, however. The exotic lens materials used in some advanced refractors can be difficult to work.) Minor deviations in the surface of a lens do not affect image quality as drastically as minor deviations in a mirror surface. Therefore, to produce the image quality of a lens, a mirror has to finished to a higher degree of accuracy.

Unfortunately, while most mass-produced reflectors have *good* optics, they do not have *great* optics, because the optical surfaces of these telescopes are relatively rough. It's the price manufacturers pay for turning out thousands of telescopes a month. The overall optical figure may be very good, but superimposed on it is a fine texture of "micro-ripples." This roughness of optical finish scatters light and degrades resolution and contrast.

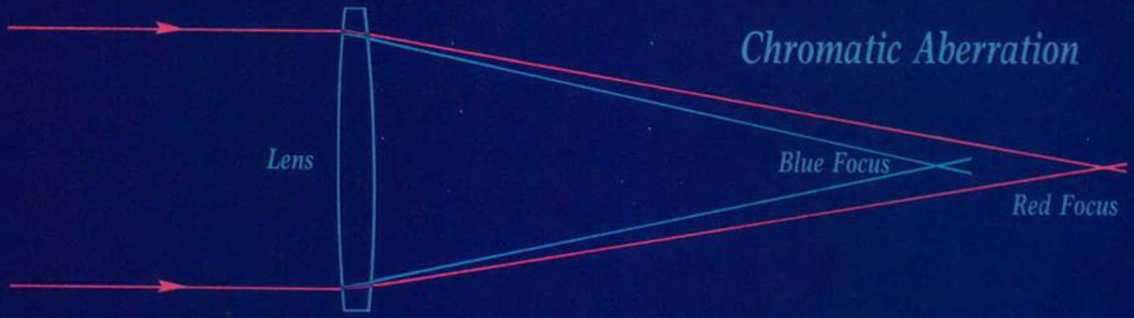
In a design as complex as a Schmidt-Cassegrain, achieving state-of-the-art optics would increase the cost of the scope several times over. Indeed, it's a credit to the manufacturers of these scopes that they can produce as good a product as they do for such a reasonable price.

Refractors also transmit more total light than reflectors do. Because some light is lost each time it reflects off a mirror's surface, only between 65 and 85 percent of the light coming into a reflector gets to your eye. The exact value depends on the number of reflections and on the mirror coatings used. A properly coated refractor lens, on the other hand, can transmit as much as 95 percent of the incoming light, depending on the number of air-to-glass surfaces. For this reason a refractor can often show as much deep-sky detail as a reflector that has 10 to 30 percent more aperture. Reflectors collect a lot of light, but they can also waste that light.

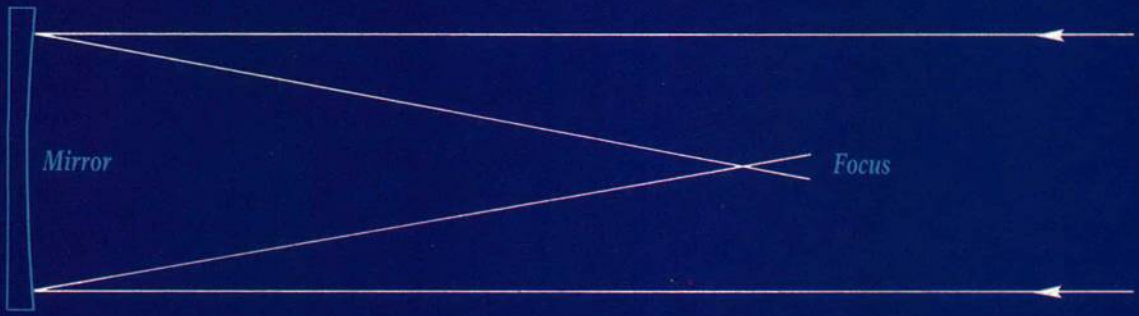
Tube Currents

Refracting telescopes are less susceptible to image-distorting air currents in the telescope tube than reflectors are. This is usually attributed to the refractor's closed tube. In fact, though, refractors aren't bothered as much by this problem as reflectors are because the light path in refractors bends away from the inside tube wall. This keeps the light away from where the worst tube currents lurk. Also, because the light only passes down the tube once, it has less opportunity to interact with these currents.

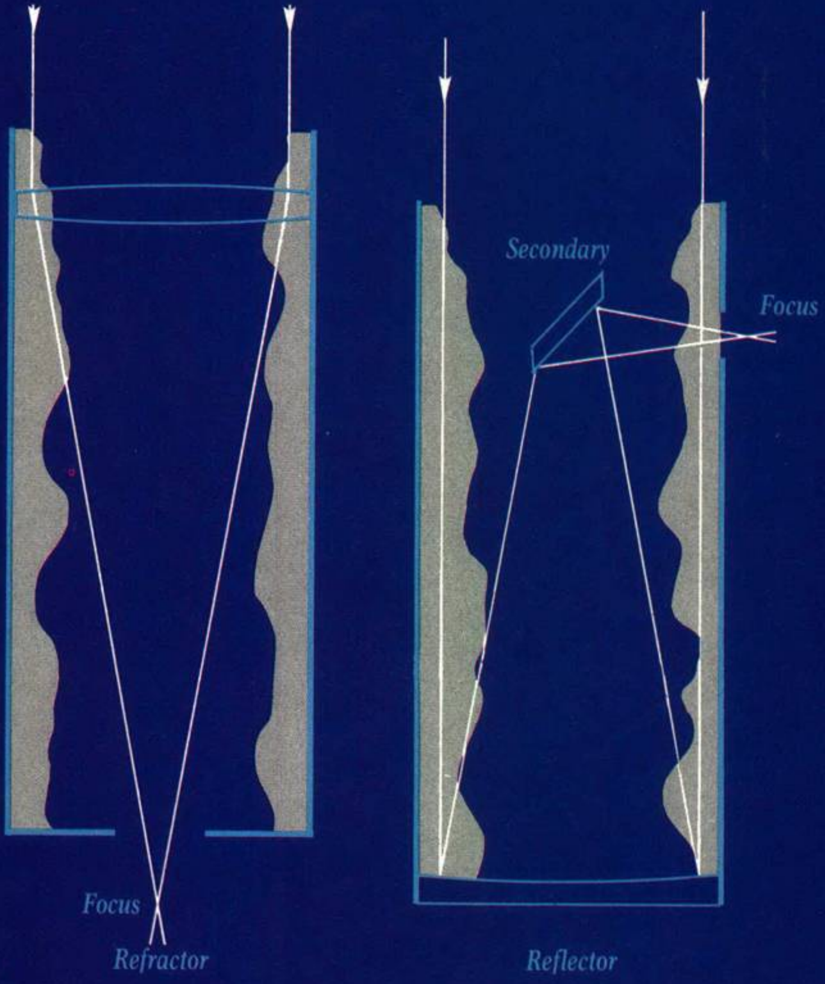
This may seem like a minor advantage,



Chromatic Aberration



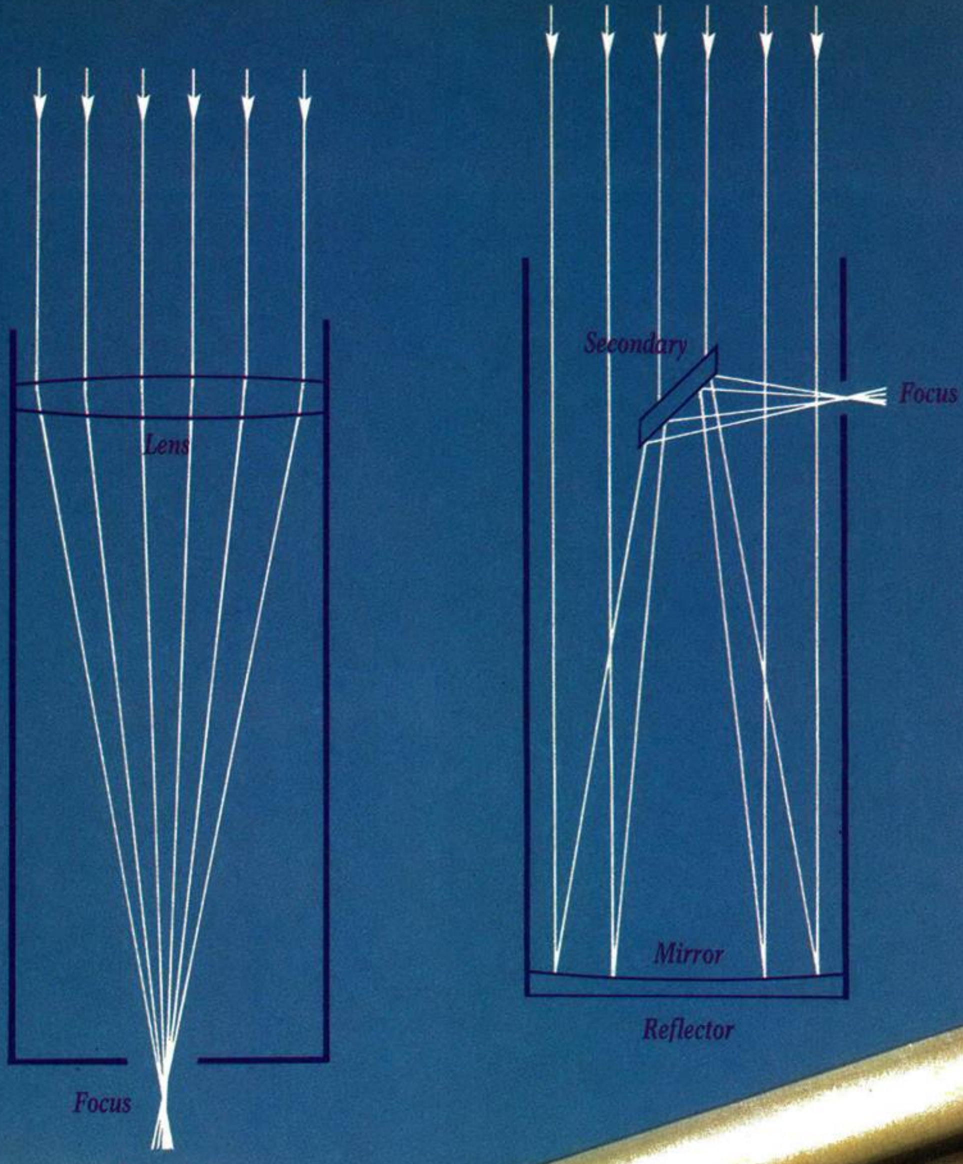
Tube Currents

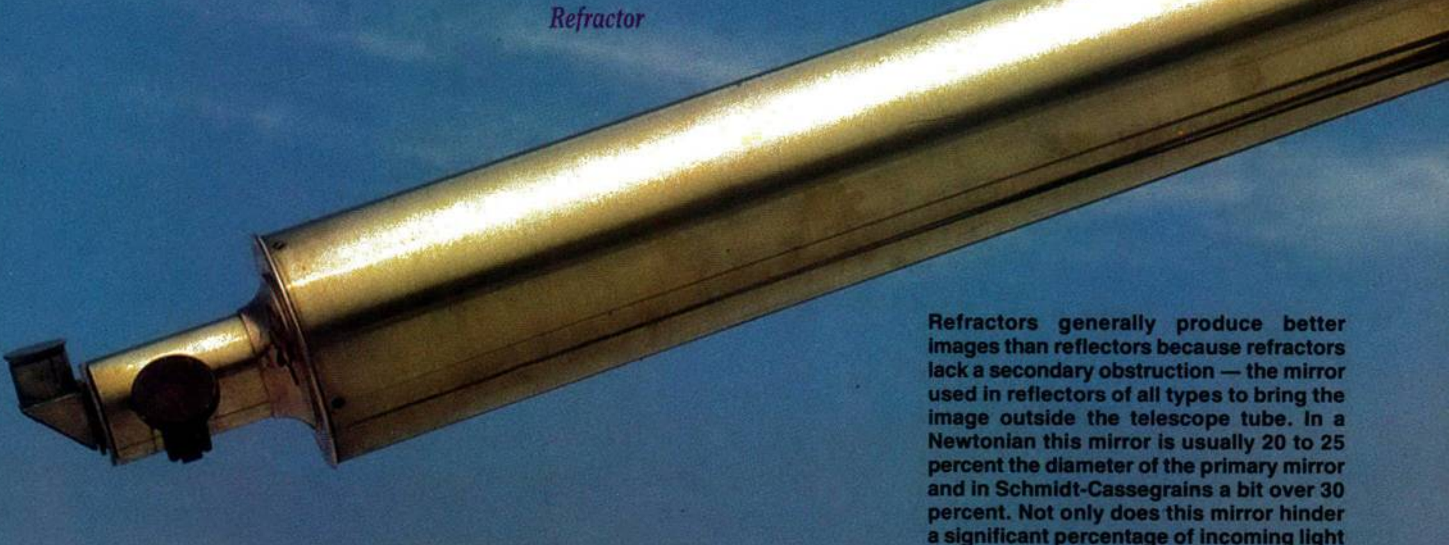


Top: The primary difficulty confronting users of refracting telescopes is chromatic aberration — the inability of a lens to bring all colors of light to the same focus. A single-element lens will bend blue light more than red light, causing images with colored halos. More advanced refractors make use of two-element achromatic and three-element apochromatic lenses, which can nearly eliminate the problem. A reflecting telescope uses a mirror to collect and focus light, so chromatic aberration does not exist.

Right: Reflectors can suffer from severe image distortion because of tube currents — air currents that occur inside the telescope tube until the scope "settles down" to the outside temperature. Reflectors are more susceptible to this problem because light passes through the tube twice — once on its way to the primary mirror and then on its way back to the secondary mirror — and the light stays close to the tube walls where the currents are worst. In a refractor, light passes through the tube only once and the lens bends light away from the tube walls.

Secondary Obstruction





Refractors generally produce better images than reflectors because refractors lack a secondary obstruction — the mirror used in reflectors of all types to bring the image outside the telescope tube. In a Newtonian this mirror is usually 20 to 25 percent the diameter of the primary mirror and in Schmidt-Cassegrains a bit over 30 percent. Not only does this mirror hinder a significant percentage of incoming light from ever reaching the primary, but it reduces the amount of contrast a reflector can transfer to the image. Refractors have no central obstruction and thus tend to produce better contrast, which is particularly valuable in lunar and planetary observing.

but in practice it can make a big difference. Reflecting telescopes of all kinds, including the closed-tube Schmidt-Cassegrains and Maksutovs, are plagued by tube currents. These currents prevent the scope from performing at its best until it has stabilized to the outside temperature, which can take from thirty minutes to the entire night for some scopes. As a result, planetary images appear just a little blurry, star images a little misshapen.

Another problem that confronts reflector owners is loss of collimation. Collimation refers to the proper alignment of the optical elements in a telescope. If a scope is out of collimation, the images it produces will not be sharp.

Collimating a scope is not that difficult, but most people rarely take the time to do it, much less to do it right. Good collimation is essential to seeing the finest planetary detail. And in a reflector the collimation can't be close enough, it has to be perfect.

A Schmidt-Cassegrain's secondary mirror is particularly sensitive. If it's even slightly out of alignment, the resulting images will be soft and fuzzy. If you've wondered why you've never seen more than two cloud belts on Jupiter, even after your scope has settled down in the cold night air, check the scope's collimation.

Field of View

Short-focus refractors in the f/4 to f/6 range are excellent for wide-field deep-sky observing. They are superior to short-focus Newtonians because they don't suffer from coma, the aberration that makes stars look like seagulls at the edge of the field. Refractors can provide pinpoint star images right to the edge. A two- to four-degree field where all the stars actually look like stars is a breathtaking sight. Today's top-of-the-line eyepieces, like the Naglers and Ultra Wide Fields, are capable of providing superb images across a wide field of view and are a perfect match for refractor optics.

The Secondary Obstruction

Reflectors have a secondary mirror that redirects the light from the primary mirror out of the telescope tube to where the image is formed. Unfortunately the secondary mirror is located in the tube, so it blocks a portion of the incoming light.

A lesser-known problem associated with the secondary mirror is that diffraction reduces the image contrast. A secondary mirror that measures 30 percent of the diameter of the main mirror — most Schmidt-Cassegrains have secondary mirrors slightly larger than that — reduces contrast as much as a 1/4-wave error in the optics of your system. Fast Newtonians have diagonals that obstruct 20 to 25 percent of the primary mirror diameter and do not suffer as much from this effect.

In other words, the secondary obstruction in a Schmidt-Cassegrain reduces image contrast to only 40 percent of the theoretical maximum. In comparison, a good apochromatic refractor with no central obstruction is capable of a contrast efficiency of some 75 to 95 percent of maximum. But the real problem emerges when the reflector's central obstruction is combined with less-than-perfect optics (an all too frequent combination in mass-produced reflectors). In that case the contrast can drop to as low as 20 percent of the theoretical maximum, which means the final image has only 20 percent of the contrast inherent in the light that entered the telescope.

This loss of contrast seriously affects low-contrast features near the resolving limit of the telescope. For this reason fine detail in lunar and planetary images is particularly difficult to see. The low contrast washes out thin cloud belts on Jupiter, ring divisions around Saturn, and subtle dark markings on Mars.

Deep-sky observers are not bothered by this problem nearly as much as lunar and planetary observers are because deep-sky features are usually nowhere near the resolving limit of the telescope.

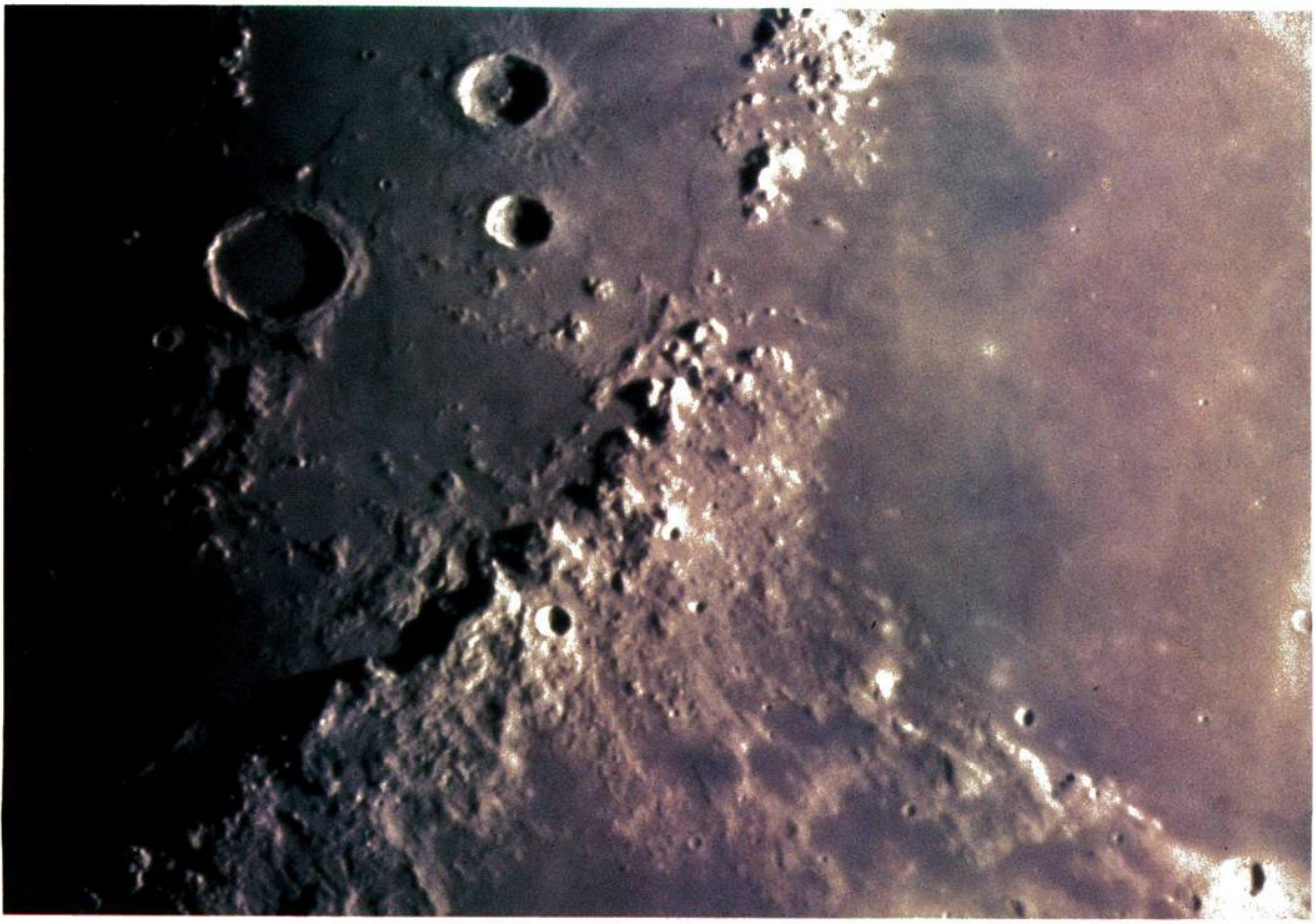
Some people may argue that the contrast degradation caused by a secondary mirror is too small to be noticeable. But it's an optical fact: a 30 percent obstruction reduces the contrast your scope can deliver, no matter how good its optics are, to that of a 1/4-wave system. If you want the best optical performance, you have to go to an unobstructed telescope like a refractor. (A long-focus Newtonian with a small secondary mirror is a good second choice.)

What about Color?

The refractor's principal imperfection is that it focuses different colors of light differently. Light passing through a lens is bent by an amount that depends on color: blue light is bent the most and red light the least. Thus, light of different colors is focused at different distances from the lens. Known as chromatic aberration, this effect generally manifests itself as a bluish halo of unfocused light surrounding bright objects. In a worst case scenario — a large-aperture, short-focus, two-element achromat refractor — chromatic aberration significantly degrades lunar and planetary images.

Traditionally, the only way to reduce chromatic aberration was to resort to long focal-length systems. This, however, resulted in an unwieldy tube length for any scope over 4 inches in aperture. But today there is an alternative. Chromatic

Photo by A. L. Schmidt



Optimizing Your Scope

Refractors may perform better than reflectors in some areas, but that does not mean reflector owners should despair. There are many ways to improve the image quality of a reflecting telescope.

Newtonian Reflectors

If you're planning to buy or make a Newtonian reflector, consider opting for a longer focal length, say an f/8 design. This has several advantages over shorter focal-length scopes. First, longer focal-length reflectors require a smaller secondary mirror, and this reduces light loss from the obstruction and contrast loss caused by diffraction. This design also improves the edge-of-field performance, although the field is not as wide as it is in shorter focal-length reflectors. Finally, the overall optical quality of the scope will most likely be better because a high-quality, long focal-length mirror is easier to make than a fast f/4 or f/5 mirror.

Even Dobsonian fans might want to opt for a long focal-length mirror. This would be true to John Dobson's original design: his designs are around f/7, not the f/4.5 common in today's models.

Of course the major disadvantage of a long focal-length instrument is that the tube is longer and thus the telescope is less portable and more difficult to mount solidly. Take consolation in knowing that some of the best views of planetary detail have been reported by owners of long-focus Newtonian scopes.

Make sure the tube is significantly wider than the mirror — put an 8-inch mirror in a 10-inch tube, for example. This will keep tube wall currents away from the light path. The mirror cell should be mounted so air can flow around it and through the tube. The scope will then reach equilibrium with the outside temperature faster. Some scopes even have fans at the bottom of the tube to circulate air.

SCTs and Maksutovs

Throw away your prism star diagonal. Replace it with a high-quality mirror diagonal that has enhanced coatings. The mirror should be full-thickness Pyrex, not a piece of thin plate glass like some less expensive diagonals.

Allow your scope time to settle to the outside air temperature. Schmidt-Cassegrain and Maksutov scopes can take an hour or more to acclimate to the night air. In the case of these scopes, some of the tube currents come from warm air rising off the baffle tubes. To see this effect for yourself, throw a bright star out of focus. Do you see what looks like a plume of smoke rising from the central black shadow of the secondary mirror? If so, your scope is not settled down. These tube currents will create astigmatic star images and blurry planets.

For All Scopes

The performance of any telescope can be improved by following a few simple guidelines. Here are "the three C's" for optimizing your scope — cleaning, collimation, and coatings.

Cleaning. Keep your optics, including the eyepieces, clean. Layers of dust or oil that build up over time will scatter light and reduce contrast. This prescription is given with some trepidation, however. In a frenzy for sparkling optics many people inflict scratches or blemishes on the lens and mirror coatings. This defeats the purpose of clean optics because the scratches degrade images just as effectively as dirt does. So make sure you clean sparingly and carefully.

Collimation. Keep your telescope collimated. Scopes that are moved frequently will need to be collimated now and then. Subjecting scopes to extremes of hot and cold can also loosen the collimation screw settings. To collimate a commercially manufactured telescope, follow the instructions that came with it.

The secondary mirror in a typical Schmidt-Cassegrain scope amplifies the light beam from the f/2 primary mirror into an f/10 focal ratio. For this reason a slight tilt of the secondary mirror results in a major loss of image quality. Usually you will only need to give the adjustment screws a slight turn to return the scope to the proper alignment. Don't adjust them with a heavy hand and don't overtighten them — that can pinch the mirror and distort images.

Coatings. If you are about to purchase a telescope or mirror, go for the enhanced-coatings option. These corrector lens and mirror coatings increase the total amount of light transmitted through the system by 10 to 20 percent, which effectively increases the aperture.

Although coatings will give you greater light transmission, they will not necessarily bring better contrast. In addition, coatings layered onto an already poor optical surface can actually increase the random scatter of light. The best contrast is still found in top-of-the-line optics. — *Alan Dyer.*

Far left, top: Next year Mars will reach a very favorable opposition, when Mars will be bigger, brighter, and show more surface detail than at any time in the past seventeen years. To capture the finest surface markings, however, you will need to observe Mars with a refractor. Photo by Jean Dragesco.

Bottom: The Moon offers a wealth of detail for all observers, though the superior contrast offered by a refractor will reveal particularly hard-to-see features. Photo of the lunar Apennine Mountains by Peter Alway.

aberration can be nearly eliminated with either high-dispersion lens materials like calcium fluoride or a three-lens apochromatic design. These designs do not require long focal lengths, so the tube can remain relatively short.

The Market Diversifies

Interest in refractors has surged in the last few years because the price for apochromats has come down considerably. This is due to the availability of new types of glass at a lower cost, computer-aided design, and the willingness of small manufacturers to produce the best for a marketable price.

The customers are there, ready to buy every quality refractor these companies can make and then some. Demand far outstrips supply. The same thing happened when the Schmidt-Cassegrain was introduced to the market back in the early 1970s and the Dobsonian reflector in the early 1980s. You had to wait in line to get one. The wait for refractors is getting longer and longer.

Amateurs are moving away from the brute force method of simply increasing aperture to see more. They realize that a smaller scope with high-quality optics can reveal just as much detail, if not more, as a big scope with average optics can — in a more portable package.

Reflectors of every type and size will always have a place in amateur astronomy. Refractors, no matter how good, will never totally replace them. Indeed, many amateurs will most likely opt to have both types of telescopes because each has an important role to play.

With a little luck we'll see more manufacturers entering the field, which will ease the current refractor shortage and perhaps push prices down. Only if the specialized glass they need becomes unavailable or too costly will we return to a time when 4- and 5-inch refractors cost several thousand dollars. For the time being, the future looks as clear and bright as the view through one of those high-quality refractors.

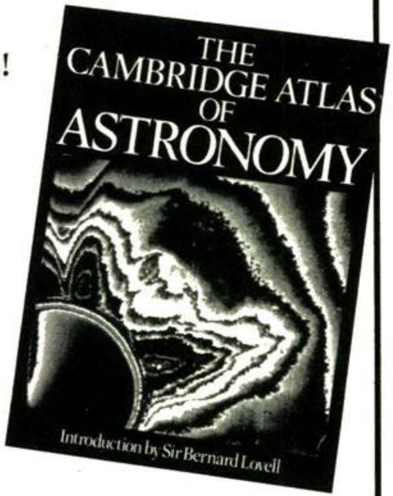
Alan Dyer is program director at the Edmonton Space Sciences Centre in Edmonton, Alberta, and a member of the Royal Astronomical Society of Canada. He wishes to thank fellow RASC member Peter Ceravolo for comments made during the preparation of this article.

The Cambridge Atlas of Astronomy

The complete one-volume astronomy library!

Absolutely up-to-date, filled with stunning pictures and diagrams, written by 44 leading astronomers and painstakingly edited for clarity — it's so good you have to SEE and FEEL this beautiful, oversize atlas to believe the fantastic value it presents!

- **1100 photos!**
- **330 color diagrams**
- **432 pages, 11″x15″**
- **covers all astronomy!**


THE CAMBRIDGE ATLAS OF ASTRONOMY
Introduction by Sir Bernard Lovell

$90.00
#30123

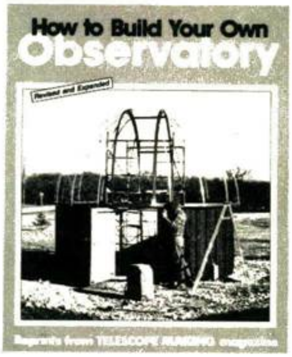
To order, use the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., 1027 N. Seventh St., Milwaukee, WI 53233. Include for postage and handling: U.S. $1; foreign $1.50. Wisconsin residents add 5% sales tax.

Revised and Expanded

How To Build Your Own Observatory

Reprints from TELESCOPE MAKING Magazine

To enjoy the hobby of astronomy to its fullest, you really need an observatory. Our booklet, updated, revised, and expanded, now contains ideas that will help you build 13 great backyard observatories — from a simple shelter from streetlights to a gleaming garage-top dome — even a wooden geodesic observatory that you CAN take with you, if you ever move. Each article, reprinted from past issues of **TELESCOPE MAKING**, includes clearly-written, easy-to-follow instructions, diagrams, and plenty of photos. If you've been dreaming of making your observing sessions more comfortable, now's the time to think about building an observatory. 64 pages, paperback. #18004.


How to Build Your Own Observatory
Revised and Expanded
Reprints from TELESCOPE MAKING magazine

ONLY
$5.95

To order, use the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., 1027 N. Seventh St., Milwaukee, WI 53233.

Include for postage and handling: U.S. $1; foreign $1.50. Wisconsin residents add 5% sales tax.

SARNA DEEP SKY ATLAS

Your Key to the Deep-Sky Universe!

The **Sarna Deep Sky Atlas** was created by Tom Sarna, an experienced deep-sky observer who wanted to make finding galaxies, clusters, and nebulae easy.

Its 102 charts show you the star patterns surrounding 255 deep-sky objects down to −40° declination (including all the Messier objects), and provide step-by-step directions on how to get there from bright, easy-to-find guidepost stars.

Included with the charts are a poster-size finder map, showing the charts' positions on the sky, and complete instructions.

With the Sarna Atlas, you'll be an expert deep-sky observer in no time!

- **102 charts, each 8½″ x 11″**
- **Plots locations of 255 deep-sky objects**
- **Includes finder map and instructions for use**
- **Printed on heavy-weight stock with white stars on handsome midnight blue background**
- **Shrink-wrapped in protective plastic**

$29.95
#30072

To order, use the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., 1027 N. Seventh St., Milwaukee, WI 53233.

Include for postage and handling: U.S. $1; foreign $1.50. Wisconsin residents add 5% sales tax.

Edelman's

Meade REBATE VALUES

8" UNITS
2080LX5-MCSO . . . **$1,699.95**
2080LX3-MCSO . . . **$1,399.95**
2080 GEM HTC **$799.95**

10" UNITS
2120LX5-MCOG . . . **$2,649.95**
2120LX3-MCSO . . . **$2,289.95**
2120 GEM-MCSO . . **$1,699.95**

4" UNITS
2045LX3 . . . . **$789.95**
2045 . . . . **$579.95**
2045&2045LX3 include table top tripod

"NEW" MEADE MTS TELESCOPES

MTS SN-6 *Schmidt-Newtonian 6" (F-5)* **$549.95**
MTS SN-8 *Schmidt-Newtonian 8" (F-4)* **$799.95**
MTS SC-8 *Schmidt-Cassegrain 8" (F-10)* **$799.95**
MTS SC-10 *Schmidt-Cassegrain 10" (F-10)* . . **$1399.95**

ACCESSORIES

788 *Motor Drive* **$124.95**
790 *LX3 Drive Base* **$439.95**

Schmidt-Newtonian units have White Fiberlite Tubes
Schmidt-Cassegrain units have Hi-Gloss Blue Tubes
All Units incorporate Fork Mounting & Pier Assembly

Our Meade Freight Policy-*Sorry! at these prices we must charge $30.00 East of the Mississippi & $40.00 West of the Mississippi.*

TeleVue SERIES II EYEPIECES

PLOSSL'S	**SPECIAL**
55mm Plossl	**$154.95**
40mm, 32mm Plossl	**$87.95**
26mm, 21mm, 17mm, 13mm	**$75.95**
10.5mm, 7.4mm Plossl	**$75.95**
WIDEFIELD	**SPECIAL**
40mm Widefield	**$239.95**
32mm Widefield	**$189.95**
24mm Widefield	**$134.95**
19mm Widefield	**$119.95**
15mm Widefield	**$109.95**

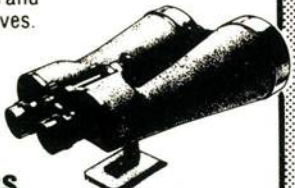
"NEW" ORACLE *3" Refractor Telescope* **$679.95**

"NEW" NAGLERS 82°	**SPECIAL**
20mm Nagler	**$299.95**
16mm Nagler	**$249.95**
12mm Nagler	**$219.95**

NAGLERS	**SPECIAL**
13mm Nagler	**$209.95**
11mm Nagler	**$199.95**
9mm Nagler	**$189.95**
7mm Nagler	**$154.95**
4.8mm Nagler	**$129.95**

CELESTRON GIANT BINOCULARS

Perfect for dark sky viewing nebulas and galaxies. Large coated 80mm objectives. Deluxe case & strap. Center focus.



CQ71100	*11x80 Giants*	**$224.95**
CQ71101	*20x80 Giants*	**$239.95**
CQ71103	*20x80 Deluxe*	**$369.95**

CELESTRON WATERPROOF BINOCULARS

7x50	*Waterproof*	10x40	*Waterproof Roof Prism*
10x50	*Waterproof*	8x30	*Waterproof Roof Prism*
8x30	*Reverse Poro*		

YOUR CHOICE **$174.95**

CELESTRON SUPER VALUES

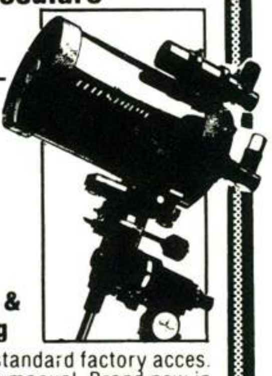
SP-C6	**$719.95**	First Scope 80	**$379.95**
SP-C80	**$649.95**	Comet Catcher	**$299.95**
C-90 Spotter	**$349.95**	11x80 Giants	**$224.95**

Call Fred First, Call Fred Last!
WE WILL BEAT ANYONE'S PRICE!

We now handel "Lumicom",
call for Cassegrain Easy Guider & Deep Sky Filter.

CELESTRON

The "NEW" 25x125 Giant Binoculars
Amazing Right Angle Roof Prism Binoculars. **$1,249.95**



SUPER POLARIS C8 STARBRIGHT

(Unit Alone)
W/Std Accessories **$1,099.95**

SKY SENSOR
$189.95

SUPER C8 PLUS Starbright & Spl.Coating

Tripod & Wedge, all standard factory acces. Plus $40.00 reference manual. Brand new in an unopened factory package & a full factory warranty. . . **$1,579.95**

DUAL AXIS QUARTZ DRIVE CORRECTOR
(CQ93533) **$199.95**

C11-STARBRIGHT . . . . **CALL**
W/WEDGE & TRIPOD . **CALL**
C14-STARBRIGHT . . **CALL**
W/WEDGE & TRIPOD . **CALL**

POWERSTAR 8

Power Star C8 with electronic drives & controls. Tripod with wheels, Star Brite and accessories **$1,699.95**

CELESTRON

COMPUSTAR COMPUTER CONTROLLER

View 600 Objects in 30 minutes.
Fantastic Teaching & Star Party Tool.

IMMEDIATE DELIVERY!

CCC8 . . . **$3,395.99**
CCC11 . . . **$6,995.99**
CCC14. . . . . **P.O.R.**

BAUSCH & LOMB

THE "NEW"

B/L 8001 Telescope **$1,249.95**
B/L 4000 Astro Telescope **$549.95**
B/L 4000 Pro Telescope **$599.95**
All 4000 Series, Include field tripod & wedge.

CELESTRON NEW ITEMS

16x70 FINDER SCOPE
$179.95

Sky Scanner	**$99.95**
Comet Reflector C0114	**$239.95**
Table Top Reflector	**$139.95**
Comet Catcher JR.	**$99.95**
C-90 Big Eye	**$299.95**
Moto Focuc for C-8	**$84.95**
Telrad Finder	**$44.95**
Optical Cleaning Kit	**$19.95**
Sky Sensor AC Power Supply	**$44.95**
8x50mm Finder Scope	**$59.95**
C-80 Refractor	**$329.95**
Guide Scope 40/800	**$79.95**
Guide Scope 60/800	**$119.95**
Image Correcter 1¼"	**$38.95**
Slow Motion Control	**$36.95**

Edelman's

VISA & MASTER-CARD accepted

add 2% COD (add $5.00) Cash or Certified Checks only - 5% Restocking Fee
Store Hours: *(Both Stores) Daily 10-9. Sat 9-5:30. Sun 11-5*

PHONE & MAIL ORDERS
Wayne Store Only (201) 227-2515
Daily: 11-7, Sat. 11-5:30

AST-987A

Metro NY. Area - 30 Min. West of NYC
WAYNE N.J.
465 RT. 46, at RTS. 46 & 23
WAYNE N.J. Zip 07470
(201) 256-2071 *or* (201) 227-2515
Phone, Mail Orders & Showroom

Del/Val. Showroom, 5 Min. from Center City
PENNSAUKEN N.J.
RT. 130 So. Airport Circle
PENNSAUKEN N.J.
(609) 665-4244
Sorry No Mail order in Pennsauken

1987 Telescope Buyers' Guide

by the staff of ASTRONOMY

If there were one "best" telescope, we would simply announce: "The best telescope is the Quatron 500 Model XS2," and that would be that. Instead there are many "best" telescopes — and which is best for you depends on *you*.

If you're a first-time buyer, the best telescope must be versatile and not too expensive. You'll want to look at a medium-aperture reflector or a small refractor or catadioptric to learn what astronomy has to offer with it.

When the time comes to buy a second telescope, you'll want to look at the market carefully. The difference between the types of telescopes is this: inch for inch, refractors give you the best image quality, reflectors deliver the most aperture per dollar, and catadioptrics are compact and convenient.

But the choice depends on you. Perhaps you've developed a passion for spotting galaxies and have begun to yearn for a giant Newtonian "light bucket." Or you're keen on sketching the advance of the Martian seasons during next year's opposition of Mars. The solution might be a large apochromatic refractor. You may want to frame the nebulae and fall head over heels in love with astrophotography. Suddenly a Schmidt-Cassegrain reflector with full photo accessories could be the only logical choice.

Selecting an Aperture

The table of comparative size classifications on page 76 shows what apertures are generally classed as small, medium, or large for each type of telescope. This size scale depends on aperture, price, and performance and is essentially a rating of value received per dollar spent. What it says is that you will receive approximately equal value in a small telescope if you buy a 3-inch refractor, a 4-inch catadioptric, or a 6-inch reflector.

That does not mean the three telescopes will perform identically. A well-made 6-inch Newtonian reflector will show you fainter stars and give you better resolution than a 3-inch refractor or 4-inch catadioptric, but a 3-inch refractor might give slightly sharper images than a 4-inch catadioptric. The catadioptric, however, is only twelve inches long, whereas the refractor and reflector are four feet long. Overall, the utility of each telescope type in a given size nets out about the same for an average observer.

The Right Mount

Of the three basic mountings — equatorial, altazimuth, and Dobsonian — you will have to choose one. Although each type offers you certain advantages and suffers from certain disadvantages, any of them is adequate for your first forays into stargazing.

But if you want something more — to observe the Moon and planets at high magnification, take photographs through your telescope, or observe for long periods of time — we recommend an equatorial mounting.

The advantage of altazimuth mounts is that they are inexpensive. Despite this, we do not recommend them for adults interested in more than casual stargazing. To follow a celestial object, you have to keep twiddling knobs that move the telescope — first a little up, then a little right, then a little up, and so on.

Dobsonian mounts are technically altazimuth mounts, but there are no knobs to turn. Instead you simply push the telescope where you want it to go. Most Dobsonian mounts come with big, low-power "light-bucket" Newtonian reflectors made for low-power viewing. For deep-sky observers interested in the biggest telescope for the smallest dollar, we recommend the Dobsonian.

How BIG Is It?

A big *aperture* is a blessing; a big *telescope* is a mixed blessing. Only you can decide whether your lifestyle can accommodate a 350-pound monster telescope that stands eight feet high. Where will you put it? In the spare bedroom? In the garage? Under a tarp in the backyard? Bigness is something you must consider in advance. So is weight. Remember, if you can't lift it, you won't use it.

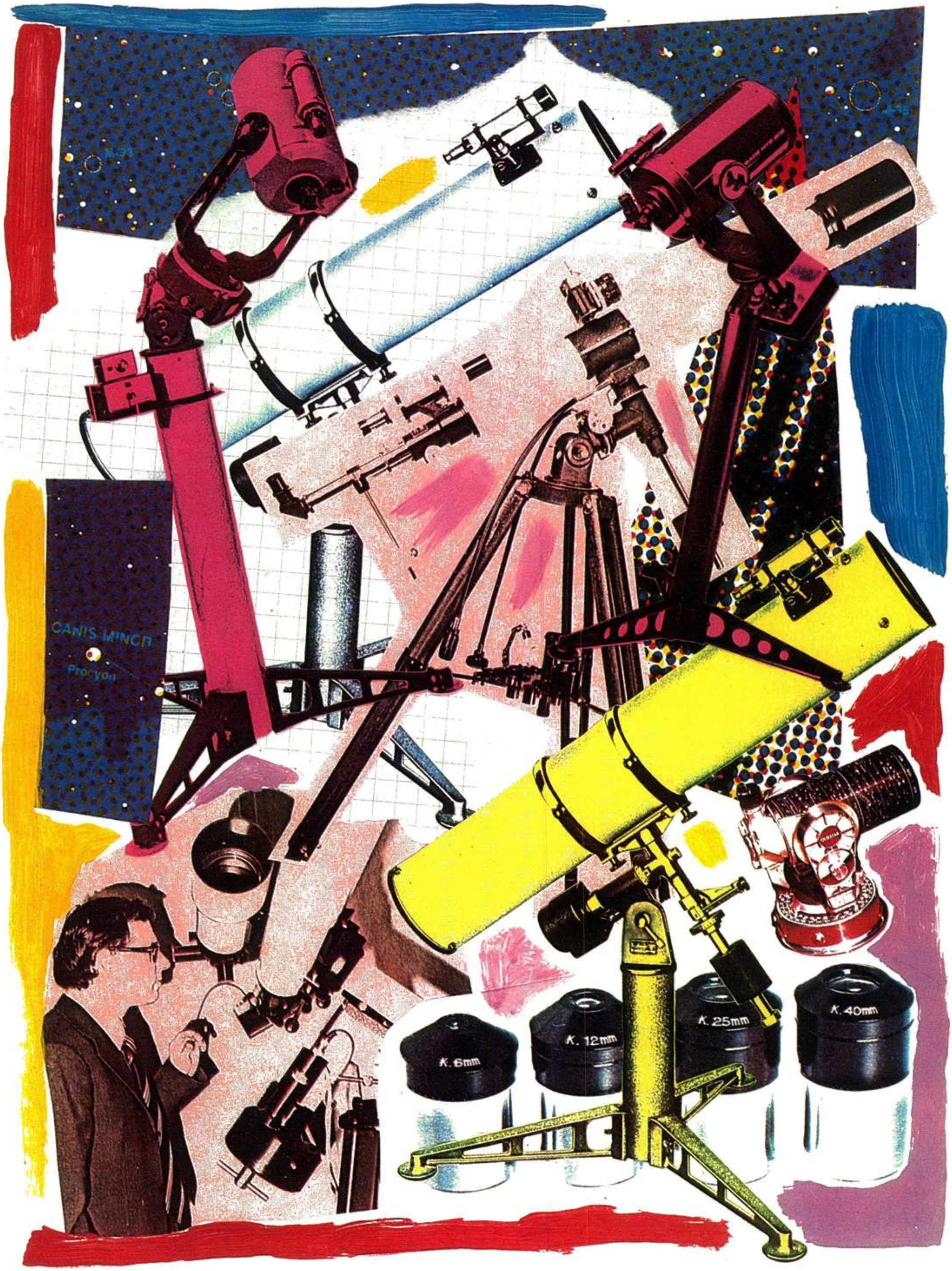
Luckily there are plenty of telescopes that aren't too big. Admittedly you'll pay a premium price for the convenience, but a telescope that's always ready and waiting in the dining room is a telescope you're sure to use whenever the night is clear.

If you think you're going to be serious about astronomy, try to pick a telescope you can leave set up and ready to go instead of one you'll have to unpack each time you use it. The exception to the rule, of course, is a telescope that's ready to go as soon as you unpack it.

Can You Afford It?

How much is too much to spend on a telescope? The answer depends on you, your income, your spouse, and the importance of your kids' college educations. If

Illustration by Todd Graveline


CANIS MINOR
Procyon
K. 6mm
K. 12mm
K. 25mm
K. 40mm

you spend more money than you're comfortable spending, you'll probably want to chuck the whole thing. Be sensible — and kind to yourself. Make your first telescope a small- or medium-size instrument you can use when you feel like using it and leave alone when you need a little relief from the call of the stars.

Let your second telescope be the large one.

Telescope Specifications

To help you choose a telescope, we've compiled specifications for 151 popular telescopes from twenty-four manufacturers. Because performance and price structure varies for the different kinds of telescopes, we compiled separate tables for refractors, reflectors, and catadioptric telescopes.

Within each table the telescopes are grouped by manufacturer. This allows you to examine telescopes from each maker and see the relationships between aperture, features, and price. We have not included every telescope on the market either because two models are virtually identical or because the "low end" of the product line is not, in our opinion, suitable as a telescope for a beginning adult amateur astronomer. We have also consolidated product lines in which one model is available in a range of apertures.

The information in the tables was obtained from the telescope manufacturers or distributors and has been checked for accuracy. Nevertheless, we recommend that you obtain current specifications and check prices before buying, because both specifications and prices are subject to change without notice.

Aperture. The diameter of the primary lens or mirror is the aperture of a telescope. In general, the larger the aperture the better. But larger telescopes cost more, which can limit what's feasible for you to own.

The entry in this column gives the aperture of the instrument in inches, though many telescope manufacturers now specify their apertures of the telescopes in millimeters. As a quick jog to your memory, 60mm is 2.4 inches, 80mm is 3.1 inches, 90mm is 3.6 inches, 102mm is 4 inches, and 200mm is 8 inches.

Focal ratio. The focal ratio is the effective focal length of a telescope divided by its aperture. This number gives a rough indication of what observing tasks the telescope will perform best. Telescopes with focal ratios between f/3.5 and f/5 are generally intended for deep-sky viewing at low magnification or for astrophotography. Focal ratios from f/6 to f/11 — "all-around" focal ratios — are typical of telescopes designed for general observing. Most catadioptrics fall in this range. Focal ratios greater than f/12 are generally best for lunar and planetary viewing at relatively high magnification. Many refractors fall in this range.

Type of optics. Reflectors may have Newtonian (NEWT) or Cassegrain (CAS) optical systems, although most reflectors made today are Newtonians. Cassegrain reflecting telescopes are similar to the Schmidt-Cassegrains so popular today but without the corrector plate of the former.

We show four types of refractors: achromatic lens refractors (ACH), apochromatic lens refractors (APO), two-element apochromats (2APO), and fluorite lens refractors (FL). Most achromatic refractors have slight residual chromatic aberration. In small- and medium-size refractors only an expert can spot the aberration. In large achromatic refractors, bright objects have purplish halos around them.

We show four types of catadioptric telescopes: Schmidt-Cassegrain telescopes (SCT), Maksutov-Cassegrain telescopes (MAK), Schmidt-Newtonians (SN), and hyperbolic astrographs (HA). The SCTs and MAKs are compact, long-focus systems designed for portability and versatility.

Both Schmidt-Newtonians and hyperbolic astrographs are similar to ordinary Newtonians. In the former the mirror is spherical and a corrector plate has been added to give better images over a wider field of view. In the latter a group of lenses just before focus removes residual aberrations from the primary, which results in an instrument well suited for prime-focus astrophotography.

Mounting type. The four most common types of mounting are German equatorial (GE), fork equatorial (EF), Dobsonian (DOB), and altazimuth (AA). We do not recommend an altazimuth mounting for a first telescope intended for an adult interested in pursuing astronomy further. At magnifications above 50 or 60 power tracking is difficult.

Clock drive. Equatorial mountings may include a clock drive so the telescope will automatically follow celestial objects across the sky. We distinguished between two types of clock drives: those with worm-gear drives (W) and those with spur-gear drives (S). If the telescope has no drive, there is a dash in the column.

For visual observing, spur-gear drives are adequate, but for astrophotography well-made worm gears provide much better tracking. The manufacturers of medium- to large-size catadioptrics have upgraded the quality of the worm gears in their products because the astrophotographic capability is often an important selling point.

Slow-motion controls. A valuable feature for photography and high-magnification viewing are slow-motion controls, that is, little motors or manual controls that microadjust the pointing of the telescope. Slow-motion controls give you the ability to precisely center that planet you're watching or to track on a guide star during a half-hour exposure.

If the slow-motion controls are included in the price listed for the telescope, you'll see a check mark in this column. Even if there is no check, optional slow-motion controls may be available though not included in the base prices.

Setting circles. Equatorial telescopes may include setting circles, precisely marked protractorlike measuring scales on the mounting. If setting circles are included with the telescope, you will find a check mark in the column; if they are not, you will find a dash.

Drive corrector built in. No clock drive is perfect; even the best worm gears suffer from minor errors. For long-exposure astrophotography, guiding is necessary so the stars are perfect pinpoints of light on

Comparative Size Classifications (in inches)

Type	Small	Medium	Large
REFRACTOR	3	5	7+
CATADIOPTRIC	4	8	12+
REFLECTOR	6	10	16+

the film. If the telescope includes a built-in electronic drive corrector, this column is checked.

Eyepieces included. This column gives the number of eyepieces included in the purchase price of the telescope or a dash if none is included.

Finder Scope. Finders include a cross-hair eyepiece that allows you to point the main telescope exactly at a faint celestial object. If the telescope includes a finder telescope, you will find its optical specifications listed in the table. "8x50" means the finder magnifies eight times and has a 50mm aperture. If the telescope does not include a finder, we recommend that you purchase a finder.

Focuser size. The focuser of the telescope must accept the eyepieces you will use. Standard eyepieces are 1.25 inches in diameter; we recommend that you purchase a telescope that takes this size eyepiece. If you are seriously interested in astrophotography or deep-sky observing, you should consider a telescope that accepts 2-inch-diameter eyepieces and an adaptor to hold 1.25-inch eyepieces. We do not recommend 0.965-inch eyepieces or focusers.

Total weight. Most adults can handle fifty pounds without difficulty, especially if the telescope breaks down into two or more subassemblies. In general, though, telescopes weighing more than a few hundred pounds should be mounted permanently outdoors or in an observatory building.

Limiting magnitude / Resolution. We have shown the magnitude of the faintest star you should be able to see with the telescope and the theoretical limit of its resolution. Under clear, dark skies skilled observers can see stars that are fainter than the limiting magnitude. Under light-polluted urban or suburban skies you may not be able to reach this limit.

Magnification / Field of view. To aid you in comparing different telescopes, we have calculated the magnification and real field of view for a standard eyepiece (a 25mm focal length eyepiece with a 60° apparent field of view). For most viewing, a magnification between six and twelve times the aperture in inches is most effective.

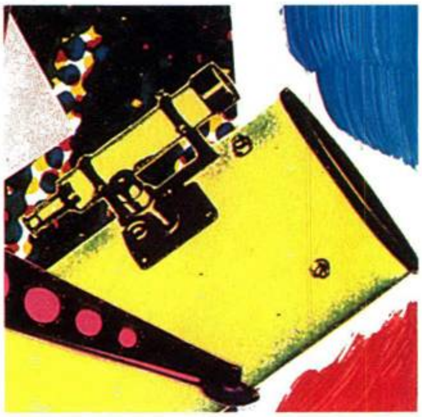
For comparison with field of view, the Moon has a diameter of 0.5° in the sky. If the field of view were 0.6°, the entire Full Moon would fit snugly into view.

Manufacturer's retail list price. You can buy most telescopes at prices well below the list price tabulated here. Check the advertisements in ASTRONOMY or call your local telescope dealer to ask for current prices.

Features. Additional features available with each make and model are listed in the key at the bottom of each table. Remember that it is often possible to buy a model that includes optional features not listed or a simpler model for a lower price that comes without the features listed. Consult the manufacturer or your local dealer for a complete listing of every model and the features offered with it.

To decide on a telescope, whether it's a refractor, reflector, or catadioptric, you must carefully estimate your future observing needs, the aperture you'll need, how big a telescope you want to lug around, and how much you can afford to spend. Use our tables to check prices and features available and then decide which telescopes are likely to be best for you.

Then get down to the details: Do you need a variable-height tripod? Will special optical coatings enhance your observing pleasure? What type of eyepieces do you want? How many do you really need? Remember that you can always buy accessories later. We believe the best strategy for beginners is to buy the best basic telescope you can afford and add accessories later.



For all types of telescopes we recommend that you consult the manufacturers' catalogs. These will help you specify your want list. After considering all the factors, make a choice that doesn't compromise your observing interests, strain your common sense, or drain your billfold. Then you'll pretty well ensure happiness in observing the sky, a hobby that can last a lifetime.

Refractors by the Dozen

Refractors fall into three groups based on how much they cost and how they're marketed. For the beginner there's an economical line, for the astronomy enthusiast there's the mass market product, and for the serious amateur astronomer there are high-quality specialty instruments.

For your first telescope, consider the economical small refractors offered by Edmund Scientific, Jason, Parks, and Swift. These companies offer 2.4- and 3.1-inch achromatic refractors, which include mount, tripod, eyepieces, and a finder scope, and range from $150 to $900. Parks also offers a 2.4-inch telescope without slow-motion controls.

The mass market instruments are generally small- or medium-aperture refractors, and they come with all the extras — mounts, finder scopes, setting circles, and tripods. Prices range from $600 to $4,000, though Meade offers several less expensive models. To satisfy a broad market, the mass market manufacturers may offer several models of the same basic hardware.

You will find refractors with the same aperture but different focal lengths. This means you can choose between a high-magnification model and low-power, wide-field instrument of the same aperture. Bausch & Lomb, for example, makes three 2.4-inch refractors with longer focal lengths than those shown on the table.

You'll often find the same optical system available on a several different mounts. Although they are not shown in the table, altazimuth mounts are also available for Celestron's 3- and 4-inch models and Meade's 2.4- and 3.1-inch models. Celestron also sells 3- and 4-inch fluorite apochromats.

TR Inc. refractors can be purchased with either an aluminum or wooden tripod; the aluminum tripods cost roughly $50 more, depending on the size of the telescope. A semiapochromat with a 3.1-inch aperture costs about $400 more than the achromat of the same size.

Pentax makes achromats and "ED" achromats. ED means extra-low dispersion glass has been used in the objective lens, so ED models are better color-corrected than standard achromats. Both types of achromats are available with either a tripod or a heavy-duty pillar mount. At the low end of the Pentax line are the "J" model achromats. These are the less expensive models, available with 2.4-inch and 3-inch apertures and altazimuth mounts.

Unitron makes three achromatic refractors with a variety of options. For instance, the 2.4-inch model is available on an altazimuth mount, on an equatorial mount, or on an equatorial mount with a clock drive; the 3- and 4-inch models are available in packages with equatorial mounts that include guidescopes, pier mountings, and cameras.

Takahashi and Goto offer telescopes through select distributors like Texas Nautical Repair Co. and R.V.R. Optical, respectively. All of Takahashi's refractors have fluorite objectives — both the achromats and the apochromats. The 2.5- and 3-inch models are designed for portability, the 3- and 4-inch models for astrophotography.

Goto's medium- and large-aperture refractors are achromats. They are intended for permanent installation in an observatory and come on a massive pier with a heavy-duty equatorial mount, clock drive, and all standard accessories.

TeleVue, Cheshire, VERNONscope, Dobbins, and Astrophysics make specialty refractors for serious amateur astronomers.

Because these companies offer just a few high-quality models, in essence you're buying a custom-made telescope when you order from them. Specialty refractors start at $1,000 for the optical tube assembly alone; mounts and other options are often sold separately.

TeleVue produces two high-quality refractors: the 3-inch three-element Oracle 3 and the 4-inch four-element Renaissance. The lens of the Renaissance, fitted in a handsome mounted brass tube, is a patented design that combines a wide, flat field with better color correction than that offered by an achromat. The Renaissance does not come with a finder because the telescopes acts as its own finder.

VERNONscope offers a 3.62-inch apochromat designed for portability. Cheshire's custom-made achromatic refractors are available in brass or polished stainless steel tubes. The 6-inch and larger stainless steel instruments cost about $1,000 more than the brass telescopes shown in the table. To match its telescopes, Cheshire custom-makes equatorial mounts from $595 to $4995. Six-inch telescopes with focal ratios of f/5 and f/10 are also available.

Dobbins' large refractors are mounted on compact, rigid mounts for astrophotography. A 10-inch model with a focal ratio of f/15 is also available.

Astrophysics' three-element apochromats are designed for very low residual aberration in a short focal length refractor. The Standard Christen apochromats are compact and versatile, but their design allows them to perform like high-quality, long-focus achromats. The Christen Super Planetary Apochromat has an f/12 objective designed for the highest possible contrast for planetary and lunar observing. The new line of medium- to large-aperture Starfire apochromats has focal ratios suitable for deep-sky observing yet offer the observer high-quality lunar and planetary images.

Refractors span the range from the simplest telescopes for beginners to superlative custom instruments for the most demanding amateur astronomer.

Variety Spices Reflector Selections

The best buys in small-aperture reflectors are those with an aperture of 4 inches or more, sold with a sturdy mount and at least two 1.25-inch eyepieces. Bausch & Lomb, Chicago Optical, Takahashi, and TR Inc. offer a variety of models with these features (although no mount is provided with the reflectors from Chicago Optical). Prices vary from $225 to over $1,000. Some are basic models, others come with clock drives, enhanced coatings, and other useful features and accessories. However, additional features raise the cost.

Bausch & Lomb's RV 5+ with equatorial mount and polar finder, manual slow-motion controls, and 1.25-inch focuser starts at $1,100. Takahashi also manufactures a 5-inch but at a considerable higher price. One of the best buys of any of the 6-inch Newtonians is Edmund Scientific's 6-inch f/6. It comes complete with a clock drive and slow-motion controls for $699.

Parks and Starliner offer basic 6-inch reflector packages (*sans* clock drive) for around $700. If you want a clock drive with these scopes, add about $200.

Rich-field telescopes — those with exceptionally wide fields for deep-sky observing and comet hunting — are pretty good buys if you're looking for a basic package. Chicago Optical's 6-inch f/4.2 rich-field telescope is only $299. Although it doesn't come with a mount, it is just a bit over two feet long and light enough to be hand-held. The image quality is reportedly very good. Telescopics offers an inexpensive, unmounted 6-inch f/5 with a brushed aluminum tube for $365. This company also offers RFTs in 8- and 10-inch sizes, but these require a stable mount.

Fine longer focus 6-inch reflectors — f/8 — are available from Starliner, Parks, Meade, and Goto. The latter scope is an import model available from R.V.R. Optical, which also carries an extensive line of other import reflectors.

Moving into higher cost stratum, both Celestron and Meade offer 6-inch f/5 Newtonian reflectors. These come with manual slow-motion controls, setting circles, and equatorial mounts for about $1,300. Celestron's model comes with a polar finder and Meade offers a polar finder as an accessory. If money is no object, Starliner's 6-inch Quality model with fiber glass tube and equatorial mount (not included in the chart) goes for $1,590. One of the most expensive 6-inch Newtonians is Takahashi's MT-160 at $2,514.

If you're considering scopes above $1,500, check out what Meade, Parks, and Starliner manufacture in the 8- to 12.5-inch range. There are numerous models to choose from. Parks' 8-inch f/6 Precision model with no clock drive and no setting circles, starts at a modest $1,000. The 12.5-inch Superior model lists for $3,299.

Meade offers two similar 8-inch reflectors for $1,590 and $1,700. They differ in focal ratio and size of the equatorial mount. Meade also offers a "Research Line" of 8-, 10-, and 12-inch reflectors on heavy-duty mounts. Prices range from $2,900 to $4,800.

Starliner offers the broadest product line of commercially available telescopes. For example, just in the 8-inch class there are five models (not every Starliner model has been listed). The 8-inch f/7 Standard with setting circles but no clock drive goes for $950. A step up from that is the 8-inch f/7 Quality, which includes a sturdier mount and a clock drive, for $1,850. Starliner's 8-inch f/4 rich-field reflector includes a clock drive and setting circles on a heavy-duty mount and costs $1,995. If you're interested in a Cassegrain or convertable Newtonian-Cassegrain reflector, Starliner offers 8-inch models starting from $1,860. Starliner also custom manufactures Newtonians and Newtonian-Cassegrain designs in apertures from 10 to 24 inches.

After looking at sophisticated telescopes, don't overlook Coulter's line of Odyssey Dobsonians. The company has recently changed the design of the rocker box, so now the mirror does not have to be removed for transport. (Some observers still prefer the old design where the mirror is removed for safety during transportation. Coulter's telescopes have a reputation for being suited to deep-sky observing.

Perhaps the best buy in the telescope market today is the Odyssey 8, an 8-inch f/4.5 Dobsonian for $239. Coulter's Odyssey 1, a 13.1-inch, is only $499, and the 17.5-inch f/4.5 Odyssey 2 is $995. The basic models do not include a finder, which is not exactly a necessity given the large field of view of these scopes, but many observers want a finder for locating small, faint objects. Delivery of one of the larger Odysseys takes between seven and nine months, but you can still get an 8-inch in two to three months.

Two other companies sell Dobsonian telescopes. Sky Designs offers a line of 14.5-, 17.5-, and 20-inch telescopes and telescope kits that features handsome woodwork, a 2-inch focuser, and a truss-style tube. Kit prices start at $1,389. Parks sells a complete line of 6-, 8-, 10-, and 12.5-inch Dobsonian models, each with a rotatable fiber glass tube, finder scope, and leveling jacks.

Our table lists fewer than half of the available models of reflectors. We simply couldn't list the many models and variations offered by manufacturers. Moreover, most telescope companies offer *numerous* accessories, your choice of several different focal lengths, and enhanced mirror coatings. You can — within limits — custom-order a reflector. You should be able to find a reflecting telescope to suit

Manufacturer and model	Aperture (inches)	Focal ratio	Type of optics	Mounting type	Clock drive	Slow motion	Setting circles	Drive corrector	Eyepieces	Finder scope	Focuser size	Total weight	Limiting magnitude / Resolution	Magnification / Field of view	Manufacturer's retail list price	Features
BAUSCH & LOMB																
4000	4	12	SCT	EF	W	✓	✓	—	2	4x	1.25	10	12.0/1.2	49x/1.2	$1000	CMT
6000	6	12	SCT	EF	W	✓	✓	—	2	6x30	1.25	18	13.4/0.8	61x/1.0	$1550	CM
8001	8	10	SCT	EF	W	✓	✓	—	2	6x30	1.25	n/a	13.9/0.6	80/0.7	$2000	CM
CELESTRON INTERNATIONAL																
C-90 Astro	3.5	11	MAK	EF	S	✓	✓	—	2	5x24	1.25	9	11.5/1.3	39/1.5	$1300	ACM
Comet Catcher	5.5	3.6	SN	—	—	—	—	—	1	—	1.25	7	13.0/1.0	20/3.0	$700	AM
SP-C8	8	110	SCT	EF	W	✓	✓	—	1	6x30	1.25	34	13.9/0.6	80/0.7	$1620	AEMPT
Super C8 Plus	8	10	SCT	EF	W	✓	✓	—	2	8x50	1.25	21	13.9/0.6	80/0.7	$2400	ACEMP
Powerstar II	8	10	SCT	EF	W	✓	✓	✓	1	8x50	1.25	48	13.9/0.6	80/0.7	$3000	ACEMP
Compustar 8	8	10	SCT	EF	W	✓	✓	✓	1	8x50	1.25	41	13.9/0.6	80/0.7	$6000	ACEMPX
C11	11	10	SCT	EF	W	✓	✓	—	1	8x50	2	57	14.5/0.4	112/0.5	$6000	ACEMP
Compustar 11	11	10	SCT	EF	W	✓	✓	✓	1	8x50	2	92	14.5/0.4	112/0.5	$12000	ACEMPX
C14	14	11	SCT	EF	W	✓	✓	—	4	8x50	2	116	15.1/0.3	156/0.4	$13200	ACEMP
MEADE INSTRUMENTS CORPORATION																
2045	4	10	SCT	EF	W	✓	✓	—	2	5x24	1.25	13	12.0/1.2	40/1.5	$1200	CEM
2045 LX3	4	10	SCT	EF	W	✓	✓	—	2	5x24	1.25	13	12.0/1.2	40/1.5	$1450	CEM
622	6	3.6	SN	—	—	—	—	—	1	—	1.25	11	13.4/0.8	22/2.7	$800	M
MTS-SN6	6	5	SN	EF	—	—	—	—	1	—	1.25	42	13.4/0.8	30/2.0	$950	FT
MTS-SN8	8	4	SN	EF	—	—	—	—	1	—	1.25	52	13.9/0.6	32/1.9	$1400	FT
MTS-SC8	8	10	SCT	EF	—	—	—	—	1	6x30	1.25	50	13.9/0.6	80/0.7	$1400	MT
2080	8	10	SCT	EF	W	✓	✓	—	2	6x30	1.25	52	13.9/0.6	80/0.7	$2400	CHMT
2080 LX5	8	10	SCT	EF	W	✓	✓	✓	1	9x60	1.25/2	52	13.9/0.6	80/0.7	$3600	CHMT
MTS-SC10	10	10	SCT	EF	—	—	—	—	1	8x50	1.25	80	14.2/0.5	100/0.6	$2500	MT
2120	10	10	SCT	EF	W	✓	✓	—	2	8x50	1.25	73	14.2/0.5	100/0.6	$4400	CHMT
2120 LX5	10	10	SCT	EF	W	✓	✓	✓	1	9x60	1.25/2	73	14.2/0.5	100/0.6	$5200	CHMT
QUESTAR CORPORATION																
Questar 3½	3.5	16	MAK	EF	W	✓	✓	—	2	6x	1.25	7	11.5/1.3	56/1.0	$2677	ACEHT
Questar 7	7	16	MAK	EF	W	✓	✓	—	2	12x	1.25	53	13.7/0.7	112/0.5	$9093	ACEHT
Wide Sky 7	7	13.5	MAK	—	—	—	—	—	1	—	2	23	13.7/0.7	95/0.6	$4795	ACE
TAKAHASHI																
ε-130	5.1	3.3	HA	GE	W	✓	✓	✓	2	6x30	2.25	46	12.7/1.0	17/3.5	$1885	EPRT
ε-160	6.3	3.3	HA	GE	W	✓	✓	✓	2	7x50	2.25	60	13.5/0.8	21/2.8	$3463	EPRT
ε-200	7.9	4	HA	GE	W	✓	✓	✓	2	7x50	3.25	160	13.9/0.6	32/1.8	$5564	EHPRT
ε-300	11.8	3.7	HA	—	—	—	—	—	—	11x70	4	100	14.5/0.4	45/1.3	$6750	ER

Type of optics: ACH (achromat), APO (apochromat), 2APO (two-element apochromat), CAS (Cassegrain), FL (calcium fluoride), HA (hyperbolic astrograph), MAK (Maksutov-Cassegrain), NEWT (Newtonian), SCT (Schmidt-Cassegrain), SN (Schmidt-Newtonian).
Mounting type: AA (altazimuth), DOB (Dobsonian), EF (equatorial fork), GE (German equatorial).
Clock drive: W (worm-gear drive), S (spur-gear drive)
Finder scope included: Magnification and aperture of finder scope included in millimeters.
Focuser size: Inner diameter of focuser drawtube in inches.

Limiting magnitude / Resolution: Magnitude of faintest star visible with telescope / Maximum resolution in arcseconds.
Magnification / Field of view: Magnification with a 25mm eyepiece / Field of view in degrees with 25mm 60° apparent field eyepiece.
Special features: A (antireflection coated), C (carrying case), E (enhanced reflection coated), F (fiber glass tube), G (guidescope), H (heavy-duty mounting), M (metal tube), O (open tube), P (polar alignment finder), R (rotating tube), S (spiral paper tube), T (tripod), X (computer controlled).
n/a: Information not available.

REFRACTORS

Manufacturer and model	Aperture (inches)	Focal ratio	Type of optics	Mounting type	Clock drive	Slow motion	Setting circles	Drive corrector	Eyepieces	Finder scope	Focuser size	Total weight	Limiting magnitude / Resolution	Magnification / Field of view	Manufacturer's retail list price	Features
ASTROPHYSICS																
Standard 5" f/8	5	8	APO	—	—	—	—	—	—	—	1.25/2	13	12.7/0.9	40/1.5	$1295	AM
Standard 6" f/8	6	8	APO	—	—	—	—	—	—	—	2	19	13.4/0.8	49/1.2	$1695	AM
Super Planetary	6	12	APO	—	—	—	—	—	—	—	2	21	13.4/0.8	72/0.8	$1760	AM
4" f/8 Starfire	4	8	APO	—	—	—	—	—	—	—	2	9	12.0/1.1	32/1.9	$1195	AM
5" f/8 Starfire	5	8	APO	—	—	—	—	—	—	—	2	14	12.7/0.9	40/1.5	$1660	AM
6" f/9 Starfire	6	9	APO	—	—	—	—	—	—	—	2	20	13.4/0.8	54/1.1	$2395	AM
7" f/9 Starfire	7	9	APO	—	—	—	—	—	—	—	2/2.7	33	13.7/0.7	63/1	$3600	AM
BAUSCH & LOMB																
Banner Astro 454	2.4	15.2	ACH	GE	—	✓	✓	—	3	5x24	1.25	n/a	10.5/1.9	36/1.7	$460	T
Banner Astro 1000	3.1	12.5	ACH	GE	—	✓	✓	—	3	6x	1.25	n/a	11.0/1.5	40/1.5	$1000	PT
CELESTRON INTERNATIONAL																
SP-C80	3	11.4	ACH	GE	—	✓	✓	—	1	6x30	1.25	38	11.0/1.5	36/1.7	$1330	AEMPT
SP-C102	4	9.8	ACH	GE	—	✓	✓	—	1	6x30	1.25	47	12.0/1.1	39/1.5	$1700	AEMPT
SP-C102F	4	9.0	FL	GE	—	✓	✓	—	1	6x30	1.25	46	12.0/1.1	36/1.7	$3500	AEMPT
CHESHIRE																
5" f/5	5	5	ACH	—	—	—	—	—	n/a	—	2	12	12.7/0.9	25/2.4	$1595	M
5" f/15	5	15	ACH	—	—	—	—	—	n/a	—	2	32	12.7/0.9	76/0.8	$2195	M
6" f/8	6	8	ACH	—	—	—	—	—	n/a	—	2	31	13.4/0.8	49/1.2	$3194	M
6" f/15	6	15	ACH	—	—	—	—	—	n/a	—	2	52	13.4/0.8	91/0.7	$3495	M
8" f/12.9	8	12.9	ACH	—	—	—	—	—	n/a	—	2	110	13.9/0.6	105/0.6	n/a	M
DOBBINS INSTRUMENT COMPANY																
6" f/10	6	10	ACH	GE	W	✓	✓	✓	5	18x80	2	110	13.4/0.8	60/1	$9250	HP
6" f/15	6	15	ACH	GE	W	✓	✓	✓	5	18x80	2	115	13.4/0.8	90/0.7	$9285	HP
8" f/16	8	16	ACH	GE	W	✓	✓	✓	5	18x80	2	520	13.9/0.6	51/1.2	$12500	HP
10" f/10	10	16	ACH	GE	W	✓	✓	✓	5	18x80	2	560	14.2/0.5	100/0.6	$18500	HP
EDMUND SCIENTIFIC																
E31,611	2.4	8	ACH	EF	—	—	—	—	1	5x24	1.25	7	10.5/1.9	19/3.1	$300	AMT
GOTO																
#1062	3	12	2APO	GE	W	✓	✓	✓	5	12x40	.965	40	12.0/1.1	60/1	$5000	AFH
#1110	5	8	APO	GE	W	✓	✓	✓	6	12x40	1.25	240	12.7/0.9	72/0.8	$14900	AFH
#1120	6	15	APO	GE	W	✓	✓	✓	7	13x50	2	400	13.4/0.8	90/0.7	$55000	AFGH
#1130	8	15	APO	GE	W	✓	✓	✓	8	13x50	2	3000	13.9/0.6	120/0.5	$85000	AFGH
JASON																
313	2.4	15	ACH	GE	—	✓	✓	—	3	10x	.965	26	10.5/1.9	36/1.7	$248	AGHMRT

Type of optics: ACH (achromat), APO (apochromat), 2APO (two-element apochromat), CAS (Cassegrain), FL (calcium fluoride), HA (hyperbolic *astrograph)*, MAK (Maksutov-Cassegrain), NEWT (Newtonian), SCT (Schmidt-Cassegrain), SN (Schmidt-Newtonian).
Mounting type: AA (altazimuth), DOB (Dobsonian), EF (equatorial fork), GE (German equatorial).
Clock drive: W (worm-gear drive), S (spur-gear drive)
Finder scope included: Magnification and aperture of finder scope included in millimeters.
Focuser size: Inner diameter of focuser drawtube in inches.

Limiting magnitude / Resolution: Magnitude of faintest star visible with telescope / Maximum resolution in arcseconds.
Magnification / Field of view: Magnification with a 25mm eyepiece / Field of view in degrees with 25mm 60° apparent field eyepiece.
Special features: A (antireflection coated), C (carrying case), E (enhanced reflection coated), F (fiber glass tube), G (guidescope), H (heavy-duty mounting), M (metal tube), O (open tube), P (polar alignment finder), R (rotating tube), S (spiral paper tube), T (tripod), X (computer controlled).
n/a: Information not available.

Manufacturer and model	Aperture (inches)	Focal ratio	Type of optics	Mounting type	Clock drive	Slow motion	Setting circles	Drive corrector	Eyepieces	Finder scope	Focuser size	Total weight	Limiting magnitude / Resolution	Magnification / Field of view	Manufacturer's retail list price	Features
324	3.1	15	ACH	GE	—	✓	—	—	4	6x30	.965	43	11.0/1.5	48/1.3	$902	AGHMRT
MEADE INSTRUMENTS CORPORATION																
291	2.4	15	ACH	GE	—	✓	✓	—	2	6x30	1.25	19	10.5/1.9	36/1.7	$500	AMT
310	3.1	11	ACH	AA	—	✓	—	—	2	6x30	1.25	22	10.5/1.9	36/1.7	$850	AMT
320	3.1	11	ACH	GE	—	✓	✓	—	2	6x30	1.25	38	11.0/1.5	35/1.7	$1100	T
PARKS																
PRT-2	2.4	11.7	ACH	AA	—	✓	—	—	2	10x	.965	12	10.5/1.9	28/2.1	$199	T
PRT-46	2.4	15.2	ACH	GE	—	✓	—	—	3	10x	.965	25	10.5/1.9	36/1.7	$349	HT
PENTAX																
65	2.6	10.8	ACH	GE	—	✓	✓	—	2	6x	1.48	26	10.6/1.8	28/2.1	$1125	PT
65ED	2.6	10.8	2APO	GE	—	✓	✓	—	2	6x	1.48	26	10.6/1.8	28/2.1	$1260	PT
75ED HF	3	6.7	APO	GE	—	✓	✓	—	2	6x	1.48	26	10.9/1.5	20/3	$1425	PT
85	3.4	11.8	ACH	GE	—	✓	✓	—	3	6x	1.48	47	11.7/1.3	40/1.5	$2075	PT
85ED	3.4	11.8	2APO	GE	—	✓	✓	—	3	6x	1.48	47	11.7/1.3	40/1.5	$2400	PT
100	4	11.8	ACH	GE	—	✓	✓	—	5	6x	1.48	52	12.0/1.1	48/1.3	$3030	GPT
100ED	4	11.8	2APO	GE	—	✓	✓	—	5	6x	1.48	52	12.0/1.1	48/1.3	$3575	GPT
SWIFT																
Aerolite 863	2.4	13.3	ACH	AA	—	✓	—	—	3	6x24	.965	10	10.5/1.9	32/1.9	$275	T
859	2.4	15	ACH	GE	—	✓	✓	—	3	6x30	.965	25	10.5/1.9	36/1.7	$595	T
TAKAHASHI																
FC-65S	2.5	7.7	FL	GE	W	✓	✓	✓	2	5x25	2	32	10.5/1.8	20/3	$1464	AEPT
FC-76	3	7.9	FL	GE	W	✓	✓	✓	2	7x50	2	44	11.0/1.5	24/2.5	$1652	AEPT
FC-100E	4	8	FL	GE	W	✓	✓	✓	3	7x50	2.75	68	12.0/1.1	32/1.9	$3568	AEPT
FC-125	5	8	FL	GE	W	✓	✓	✓	n/a	11x70	4	198	12.7/0.9	40/1.5	$8394	AEHPT
FCT-65	2.5	4.9	APO	GE	W	✓	✓	✓	2	6x30	2	31	10.5/1.8	13/4.7	$2094	AEPT
FCT-76	3	6.4	APO	GE	W	✓	✓	✓	2	7x50	2.4	44	11.0/1.5	20/3.1	$2409	AEPT
FCT-100	4	6.4	APO	GE	W	✓	✓	✓	2	6x40	2.75	68	12.0/1.1	26/2.3	$4719	AEPT
TELEVUE																
Oracle 3	3	7.4	APO	—	—	—	—	—	1	—	2	6	11.0/1.5	24/2.5	$995	ACMR
Rennaisance	4	5.5	APO	GE	W	✓	✓	✓	1	21x	2	12	12.0/1.1	22/2.7	$2995	ACMR
TR INC.																
60KT	2.4	15	ACH	GE	W	✓	✓	—	2	6x30	n/a	n/a	10.5/1.9	36/1.7	$795	WT
80KU	3.1	12.5	ACH	GE	W	✓	✓	—	2	6x30	n/a	n/a	11.0/1.5	40/1.5	$889	WT
100KX	4	13	ACH	GE	W	✓	✓	—	3	6x30	n/a	n/a	12.0/1.1	52/1.2	$1380	WT
UNITRON																
128	2.4	15	ACH	GE	W	✓	✓	—	2	6x24	1.25	24	10.5/1.9	36/1.7	n/a	ACMT
142	3	16	ACH	GE	W	✓	✓	—	3	8x30	1.25	46	11/1.5	48/1.2	n/a	ACMT
152	4	15	ACH	GE	W	✓	✓	—	4	10x42	1.25	100	12/1.1	60/1	n/a	ACMT
VERNONSCOPE																
Brandon Apo.	3.6	7	APO	—	—	—	—	—	—	—	2	9	11.5/1.3	25/2.4	$995	—

Manufacturer and model	Aperture (inches)	Focal ratio	Type of optics	Mounting type	Clock drive	Slow motion	Setting circles	Drive corrector	Eyepieces	Finder scope	Focuser size	Total weight	Limiting magnitude / Resolution	Magnification / Field of view	Manufacturer's retail list price	Features
BAUSCH & LOMB																
RV 4.5	4.5	8	NEWT	GE	—	✓	✓	—	3	5x24	1.25	n/a	12.5/1.0	36/1.6	$500	PRT
RV 5+	5.1	5.5	NEWT	GE	—	✓	✓	—	3	6x30	1.25	n/a	12.7/0.9	29/2.0	$1100	PRT
CELESTRON INTERNATIONAL																
C4.5	4.5	7.9	NEWT	GE	—	✓	✓	—	1	5x24	1.25	39	12.5/1.0	36/1.6	$700	AMRT
SP-C6	6	5	NEWT	GE	—	✓	✓	—	1	6x30	1.25	50	13.4/0.7	30/2.0	$1350	AEMPRT
CHICAGO OPTICAL																
Model 150	6	4.2	NEWT	—	—	—	—	—	1	—	1.25	13	13.4/0.7	26/2.4	$299	EM
Model 108 DX	4.2	4.5	NEWT	—	—	—	—	—	2	—	n/a	6	12.5/1.0	18/3.3	$225	EM
COULTER OPTICAL																
Odyssey 8	8	4.5	NEWT	DOB	—	—	—	—	1	—	1.25	39	13.9/0.6	36/1.6	$239	S
Odyssey Compact	10.1	4.5	NEWT	DOB	—	—	—	—	1	—	1.25	65	14.2/0.5	46/1.3	$299	S
Odyssey 1	13.1	4.5	NEWT	DOB	—	—	—	—	1	—	1.25	100	14.8/0.4	60/1.0	$499	S
Odyssey 2	17.5	4.5	NEWT	DOB	—	—	—	—	1	—	1.25	206	15.8/0.3	80/0.7	$995	S
DOBBINS INSTRUMENT COMPANY																
8" f/8	8	8	NEWT	GE	W	✓	✓	✓	5	15x80	2	95	13.9/0.6	65/0.9	$5485	GHMPR
10" f/8	10	8	NEWT	GE	W	✓	✓	✓	5	15x80	2	120	14.2/0.5	81/0.7	$6950	GHMPR
8" f/20 Cass.	8	20	CAS	GE	W	✓	✓	✓	5	15x80	2	55	13.9/0.6	162/0.4	$5885	GHMPR
EDMUND SCIENTIFIC																
6-inch	6	6	NEWT	GE	W	✓	✓	—	1	7x30	1.25	65	13.4/0.7	36/1.6	$699	R
Astroscan 2001	4.1	4.2	NEWT	—	—	—	—	—	1	—	1.25	10.7	12.0/1.0	18/3.3	$359	—
GOTO																
1070	6.2	8	NEWT	GE	✓	✓	✓	—	4	9x30	.965	70	13.4/0.7	49/1.2	$4900	R
IMAGE POINT																
12.5" f/5.5	12.5	5.5	NEWT	GE	—	—	—	—	—	8x50	2	n/a	14.7/0.4	70/0.8	$4260	FHR
14.5" f/5	14.5	5	NEWT	GE	—	—	—	—	—	8x50	2	n/a	15.0/0.3	73/0.8	$4410	FRH
16" f/5	16	5	NEWT	GE	—	—	—	—	—	8x50	2	n/a	15.5/0.3	81/0.7	$5010	FHR
MEADE INSTRUMENTS CORPORATION																
Model 6600	6	5	NEWT	GE	—	✓	✓	—	2	6x30	1.25	49	13.4/0.7	30/2.0	$1300	MRT
Model 8800	8	4.5	NEWT	GE	—	✓	✓	—	2	6x30	1.25	69	13.9/0.7	36/1.6	$1700	MRT
Model 628C	6	8	NEWT	GE	W	—	✓	—	2	8x50	1.25/2	60	13.4/0.7	48/1.2	$1450	FORT
Model 645C	6	5	NEWT	GE	W	—	✓	—	2	8x50	1.25/2	55	13.4/0.7	30/2.0	$1470	FORT
Model 826C	8	6	NEWT	GE	W	—	✓	—	2	8x50	1.25/2	75	13.9/0.6	48/1.25	$1590	FORT
Model 880	8	6	NEWT	GE	W	—	✓	—	2	8x50	1.25/2	162	13.9/0.6	48/1.2	$2900	FHORT

Type of optics: ACH (achromat), APO (apochromat), 2APO (two-element apochromat), CAS (Cassegrain), FL (calcium fluoride), HA (hyperbolic astrograph), MAK (Maksutov-Cassegrain), NEWT (Newtonian), SCT (Schmidt-Cassegrain), SN (Schmidt-Newtonian).
Mounting type: AA (altazimuth), DOB (Dobsonian), EF (equatorial fork), GE (German equatorial).
Clock drive: W (worm-gear drive), S (spur-gear drive)
Finder scope included: Magnification and aperture of finder scope included in millimeters.
Focuser size: Inner diameter of focuser drawtube in inches.

Limiting magnitude / Resolution: Magnitude of faintest star visible with telescope / Maximum resolution in arcseconds.
Magnification / Field of view: Magnification with a 25mm eyepiece / Field of view in degrees with 25mm 60° apparent field eyepiece.
Special features: A (antireflection coated), C (carrying case), E (enhanced reflection coated), F (fiber glass tube), G (guidescope), H (heavy-duty mounting), M (metal tube), O (open tube), P (polar alignment finder), R (rotating tube), S (spiral paper tube), T (tripod), X (computer controlled).
n/a: Information not available.

Manufacturer and model	Aperture (inches)	Focal ratio	Type of optics	Mounting type	Clock drive	Slow motion	Setting circles	Drive corrector	Eyepieces	Finder scope	Focuser size	Total weight	Limiting magnitude / Resolution	Magnification / Field of view	Manufacturer's retail list price	Features
Model 1060	10	6	NEWT	GE	W	—	✓	—	2	8x50	1.25/2	208	14.2/0.5	61/0.9	$3440	FHORT
Model 1266	12	6	NEWT	GE	W	—	✓	—	2	8x50	1.25/2	273	14.5/0.4	73/0.8	$4800	FHORT
Model DS-10	10	4.5	NEWT	GE	—	—	—	—	1	—	1.25	72	14.2/0.5	45/1.3	$1400	OST
Model DS-16	16	4.5	NEWT	GE	—	—	—	—	1	—	1.25	225	15.5/0.3	73/0.8	$2750	OST
PARKS																
6 f/8 Precision	6	8	NEWT	GE	—	—	—	—	1	6x30	1.25	80	13.4/0.7	49/1.2	$799	FR
8" f/6 Precision	8	6	NEWT	GE	—	—	—	—	1	6x30	1.25	95	13.9/0.6	49/1.2	$999	FR
8" f/6 Superior	8	6	NEWT	GE	W	✓	✓	—	2	8x50	2	175	13.9/0.6	49/1.2	$1999	FR
10" f/5 Superior	10	5	NEWT	GE	W	✓	✓	—	2	8x50	2	185	14.2/0.5	50/1.2	$2299	FR
12.5" f/6 Superior	12.5	6	NEWT	GE	W	✓	✓	—	2	8x50	2	210	14.7/0.4	76/0.7	$3299	FR
16" Observatory	16	6	NEWT	GE	W	✓	✓	✓	2	8x50	2	320	15.5/0.3	97/0.6	$12000	FHR
Dobsonian 6"	6	8	NEWT	DOB	—	—	—	—	1	6x30	1.25	45	13.4/0.7	49/1.2	$499	F
Dobsonian 8"	8	6	NEWT	DOB	—	—	—	—	1	6x30	1.25	55	13.9/0.6	49/1.2	$649	F
Dobsonian 10"	10	5	NEWT	DOB	—	—	—	—	1	8x50	2	100	14.2/0.5	51/1.1	$999	F
Dobsonian 12.5"	12.5	5	NEWT	DOB	—	—	—	—	1	8x50	2	160	14.7/0.4	63/0.9	$1299	F
SKY DESIGNS																
14.5	14.5	4.5	NEWT	DOB	—	—	—	—	—	—	2	88	15.0/0.3	66/0.9	$1389	O
17.5	17.5	4.5	NEWT	DOB	—	—	—	—	—	—	2	138	15.7/0.2	80/0.7	$1699	O
20	20	4	NEWT	DOB	—	—	—	—	—	—	2	168	18.5/0.2	81/0.7	$2550	O
STAR LINER																
6" Standard	6	8	NEWT	GE	—	—	✓	—	2	6x30	1.25	60	13.4/0.7	49/1.2	$745	FR
6" Delux	6	8	NEWT	GE	W	—	✓	—	2	6x30	1.25	70	13.4/0.7	49/1.2	$970	FR
8" Standard	8	7	NEWT	GE	—	—	✓	—	2	6x30	1.25	85	13.9/0.6	57/1.0	$950	FR
8" Delux	8	7	NEWT	GE	W	—	✓	—	2	6x30	1.25	85	13.9/0.6	57/1.0	$1195	FR
8" Quality	8	7	NEWT	GE	W	—	✓	—	2	7x50	1.25	95	13.9/0.6	57/1.0	$1850	FR
6" Richfield	6	4	NEWT	GE	W	—	✓	—	2	7x30	1.25	70	13.4/0.7	24/2.5	$1690	FHR
8" f/12 Quality	8	12	CAS	GE	W	—	✓	—	3	6x30	1.25	120	13.9/0.6	97/0.6	$1860	FHR
10" f/12 Quality	10	12	CAS	GE	W	—	✓	—	3	10x50	2	160	14.2/0.5	122/0.5	$2950	FHR
12.5" f/12 Quality	12.5	12	CAS	GE	W	—	✓	—	3	10x50	2	240	14.7/0.4	152/0.4	$3690	FHR
10" f/10 Cass.	10	10	CAS	EF	W	—	✓	—	3	10x50	2	145	14.2/0.5	101/0.6	$3210	FHR
12.5" f/10 Cass.	12.5	10	CAS	EF	W	—	✓	—	3	10x50	2	190	14.7/0.4	127/0.5	$3990	FHR
16" Observatory	16	5	NEWT	GE	W	—	✓	—	3	10x50	1.25	575	15.5/0.3	81/0.7	$14900	FGHR
TAKAHASHI																
MT-100P	4	6	NEWT	GE	W	—	✓	—	2	6x30	1.25	34	12.0/1.2	24/2.5	$1095	EPRT
MT-130	5	6.1	NEWT	GE	W	✓	✓	✓	2	6x30	2.25	46	12.7/0.9	31/2	$1464	EPRT
MT-160	6.2	6.2	NEWT	GE	W	✓	✓	✓	2	7x50	2.25	67	13.4/0.7	40/1.5	$2514	EPRT
MT-200	8	6	NEWT	GE	W	✓	✓	✓	2	7x50	3.25	165	13.9/0.6	49/1.2	$5244	EHPRT
TELESCOPICS																
RFT-6	6	5	NEWT	—	—	—	—	—	—	—	1.25	10	13.4/0.7	30/2	$365	EM
RFT-8	8	5	NEWT	—	—	—	—	—	—	—	2	20	13.9/0.6	41/1.5	$550	EM
RFT-10	10	5	NEWT	—	—	—	—	—	—	—	2	33	14.2/0.5	51/1.2	$895	EM
TR INC.																
100 NQ	4	6	NEWT	GE	—	✓	✓	—	3	6x30	n/a	n/a	12.0/1.2	24/2.5	n/a	RT
100 NU	4	10	NEWT	GE	—	✓	✓	—	2	6x30	n/a	n/a	12.0/1.2	41/1.4	n/a	RT

you — your greatest difficulty may be too many to choose from.

The Compact, Versatile CATs

Five manufacturers offer high-quality catadioptric telescopes. Those listed in the table are made by manufacturers with good reputations for providing information on their telescopes and providing service if something needs repair or replacement.

Bausch & Lomb, a long-standing manufacturer of binoculars and other optical instruments, offers a line of three Schmidt-Cassegrain telescopes. Bausch & Lomb's telescopes come with two Plossl eyepieces and a clock drive built into the base. (An electronic drive corrector is an optional accessory.) All three models feature a black seamless aluminum tube. The model 4000 is a 4-inch f/12 telescope that weighs ten pounds.

Billed as "the world's most compact 6-inch telescope," the Bausch & Lomb 6000 is a 6-inch f/12 instrument that comes with the same accessories as the 4-inch, except that the 6-inch has a larger finder scope. The 8001 is Bausch & Lomb's entry into the 8-inch f/10 market. This telescope's features 5-inch-diameter declination setting circles easily read in low light and "ambidextrous focusing" — the focus knob placed so that right- or left-handers can reach it with equal ease.

The pioneer of mass-produced Schmidt-Cassegrain telescopes is Celestron International. In addition to its Schmidt-Cassegrain telescopes, Celestron offers a 3.5-inch Maksutov-Cassegrain, the C-90 Astro, and a 5.5-inch Schmidt-Newtonian called the Comet Catcher. The C-90 is an f/11 system with an unusual feature — helical tube focusing; to focus the instrument, turn the entire barrel. This scope comes with an equatorial fork mount and a spur-gear clock drive and its greatest attribute is portability. The Comet Catcher offers more aperture and an extremely wide field of view (it has a focal ratio of 3.6). However, the Comet Catcher as sold is an optical tube assembly without a mount or clock drive, and it must be mounted on a tripod or piggybacked on a large telescope.

Celestron's Schmidt-Cassegrains range in aperture from 8 to 14 inches and offer a variety of features. Celestron sells four versions of its popular 8-inch SCT. The SP-C8 is an 8-inch f/10 SCT on the Super Polaris German equatorial mount. The instrument comes with a 6x30 finder scope and one Plossl eyepiece. Celestron's old standby for many years, the Celestron 8, has been upgraded to the Super C8 Plus. This equatorial fork-mounted instrument comes with an 8x50 illuminated reticle finder scope, one Plossl eyepiece, and one orthoscopic eyepiece, and special high-reflectivity coatings on the primary mirror and corrector plate.

A more advanced model is the Powerstar II. It has everything the Super C8 Plus has in addition to a built-in electronic quartz drive corrector. At the pinnacle of Celestron's 8-inch SCT line is the Compustar 8. It comes with everything the Powerstar II does — plus a computer-control system with the built-in ability to locate eight thousand deep-sky objects automatically.

Celestron also makes the C11, an 11-inch f/10 instrument, and the C14, a 14-inch f/11 telescope. The C11 comes with an equatorial fork mount, an 8x50 illuminated finder scope, one orthoscopic eyepiece, and special optical coatings. The Compustar C11 is the same telescope with the addition of the computer-controlled electronics system and database of sky objects. The C14 includes an equatorial fork mount, an 8x50 illuminated finder scope, one Plossl and three orthoscopic eyepieces, and magnesium fluoride coatings on the optical surfaces to enhance reflectivity. The Compustar 14 is the same telescope with computer electronics and database added. Celestron's 11-inch and 14-inch telescopes are equipped with a 2-inch-diameter focusing tube, but 1.25-inch eyepieces can be used with an adaptor.

Meade Instruments offers eleven catadioptric telescopes. In Meade's Schmidt-Newtonian line the model 622 is the least expensive. Sold without a mounting, this 6-inch f/3.6 scope is intended for use on a camera tripod or for piggyback photography on another telescope. Meade's MTS-SN6 and MTS-SN8 are 6-inch f/5 and 8-inch f/4 Schmidt-Newtonians on equatorial fork mounts. Each comes with one eyepiece. These are stripped-down models intended as inexpensive alternatives to fully equipped SCTs.

Schmidt-Cassegrains offered by Meade range between 4 inches and 10 inches in aperture. The model 2045 is a 4-inch f/10 SCT on an equatorial fork mount. Standard with the 2045 are a 5x24 finder scope and two eyepieces. The 2045 LX3 is the same telescope with a built-in electronic quartz drive corrector. For those who want a basic 8-inch SCT, the MTS-SC8 is an equatorial fork scope with one eyepiece. The standard Meade SCT is the model 2080, an 8-inch f/10 SCT with an equatorial fork mount, a 6x30 finder scope, two eyepieces. special corrector plate coatings, and a field tripod. The 2080 LX5 is the same telescope with the added benefit of a built-in electronic drive corrector, a 9x60 finder, and one Plossl eyepiece.

Meade offers its 10-inch f/10 Schmidt-Cassegrain in three basic models. The MTS-SC10 is an inexpensive model on an equatorial fork mount that comes with one eyepiece. The standard model 2120 is equipped with an equatorial fork mount, an 8x50 finder scope, two eyepieces, corrector plate coatings, and a tripod. The 2120 LX5 includes a built-in electronic quartz drive corrector, one Plossl eyepiece, and a 9x60 finder scope.

Questar Corporation manufactures and sells a line of precision Maksutov-Cassegrain telescopes. The Questar 3-1/2 is a 3.5-inch f/16 instrument that is highly portable and rests on a compact equatorial fork mount. The Questar 3-1/2 comes with two eyepieces that provide magnifications of 50x to 130x and a flip-mirror that brings the finder scope image directly to the eyepiece. Also included in the 3-1/2 package are a solar filter, a Barlow lens, and a camera coupling set.

Two 7-inch Maksutov-Cassegrains are available from Questar, the Questar 7 and the Wide Sky 7. The Questar 7 is an enlarged version of the 3-1/2 and include an equatorial fork mount, two eyepieces providing magnifications of 105x to 320x, and a built-in flip-mirror finder scope. Also included are a solar filter, a Barlow lens, and a camera coupling set. The Questar Wide Sky 7 is an f/13.5 system designed to provide greater sky coverage than the Questar 7. The Wide Sky 7 is an optical tube assembly that comes without a mount and must be placed on a suitable mount or piggybacked on top of another telescope. The Wide Sky 7 has a 2-inch-diameter focusing tube to allow use of wide-field eyepieces.

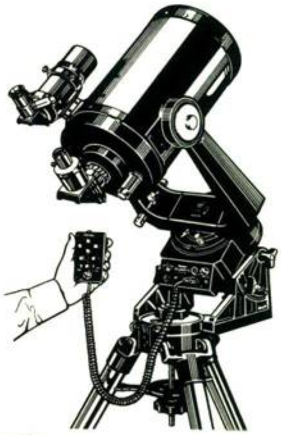
Texas Nautical Repair Co. imports catadioptric telescopes from the Takahashi Company of Japan. The Takahashi telescopes are hyperbolic astrographs — well-corrected, short-focus instruments optimized for observing large parts of the sky or photographing relatively large celestial objects. All three models have 2-inch-diameter focusing tubes. The ε-130 is a 5.1-inch f/3.3 telescope on a German equatorial mount. This instrument comes with two eyepieces and a 6x30 finder scope. The ε-160 is a 6.3-inch f/3.3 version of this design and comes with two eyepieces and a 7x50 finder scope. The ε-200 is a 7.9-inch f/4 telescope with the same standard equipment.

If you decide that you want a catadioptric telescope for reasons of portability or all-around versatility, you've got a lot to choose from.

MEADE EYEPIECES ARE WORTH A 2ND LOOK!

We would like to thank all of our customers for their support and enthusiasm. We will continue to provide you with the service and variety of product that is the policy of Northern Sky Telescopes. This month we have chosen to highlight the Meade Series 4000 Eyepieces with some specials that I think you will like. Don't forget we are still accepting entries for the drawing of the free Meade 2080 LX-5 until Sept. 30th, 1987. Good luck to everyone that has entered.

Jon Chase



Meade
2080 LX-5 w/MCOG **$1,739**

8" Schmidt-Cassegrain complete with field tripod and wedge. 9X60 RA polar illuminated viewfinder, AC/DC power supply or AA remote battery pack, quartz/pulse drive, 2" star diagonal, 2X or 8X scanning with remote. Don't forget to enter the drawing for this telescope! ***(Special price!)***

Meade
2120 LX-5 w/MCOG **$2549**

10" Schmidt-Cassegrain with all features of the 8" but 56% brighter.

Meade Accessories

#712 Dew Shield	$ 59
#36 Remote Control	85
#38 or 38A Declination	85
#39 Declination	99
#419 Illuminated Reticle	85
#784 Quartz DC Motor Drive	165
#671 Wide-Field Adapter System	119
Off Axis Guider System Complete	149

VOGEL DIGITRAK
Drive Correctors

VE-200 Single Axis DC Power	$ 99
VE-300 Single Axis AC/DC Power	139
VE-300D Dual Axis AC/DC Power	189
VE-400D Dual Axis Internal Battery	219

MOTOFOCUS

Celestron C5/C8 Motorized Focuser	$89
Meade 2080/2120 Motorized Focuser	98
Bausch & Lomb 4000 Motorized Focuser	89

TELRAD

The "right spot" finderscope	$39

Meade DS-10A **$899**

10" f4.5 reflector with motor drive. Deep Space and Nebulas have never been closer.

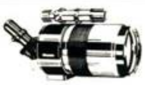
Meade DS-16A **$1795**

16" f4.5 reflector with motor drive. The telescope that provides to your eyes what others must photograph.

Meade Series 4000 Eyepieces & Barlows!

Super Plossl 6.4mm, 9.7mm, 12.4mm	$ 85
Super Plossl 15mm, 20mm, 26mm	85
Super Plossl 32mm or 40mm	105
Super Plossl 56mm	179
Super Wide Angle 13.8mm	135
Super Wide Angle 18mm	149
Super Wide Angle 24.5mm	159
Super Wide Angle 32mm	229
Super Wide Angle 40mm	295
Ultra Wide Angle 4.7mm	159
Ultra Wide Angle 6.7mm	189
Ultra Wide Angle 8.8mm	229
Ultra Wide Angle 14mm	259
#140 2x or #142 2.8x Barlow	79

With the purchase of any 2 Meade eyepieces or barlows you may choose either 1/2 off any Super Plossl 6.4mm thru 26mm or an eyepiece carrying case worth $30.00 free. Don't miss out on this exceptional special!



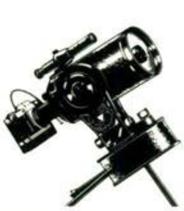
Meade 97E-II **$339**

3.5" Spotting Scope includes 45° erect-image prism and 5X21 erect-image viewfinder.

Meade 2045 **$539**

4" Schmidt-Cassegrain telescope includes 2 eyepieces, star diagonal, case, and more.

To order, or for pricing call toll free:
1-800-345-4202
For information:
1-612-545-6786
Call Jon Chase
Visit our Store:
Mon-Fri 9-6, Sat 10-2



BAUSCH & LOMB 4000 Pro Kit $499

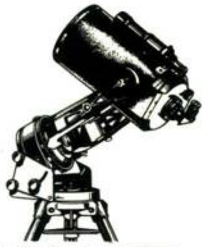
4" Schmidt-Cassegrain with enhanced optical coatings providing 29% more light transmission. Includes 2x barlow and camera adapter. When you want the most for your money.

BAUSCH & LOMB 4000 **$449**

Same as 4000 Pro minus coatings, barlow and camera adapter.

BAUSCH & LOMB Accessories

4000 Wedge & Tripod	$ 99
Solar Filter 4000	99
Polar Alignment Kit	29
Astrophotography Kit	69
10-17-26-35mm Pro Plossl Eyepiece	59



BAUSCH & LOMB 8001 Pro $1195

8" Schmidt-Cassegrain with silvered coatings provides 20% more light transmission. Full field illumination, includes field tripod & wedge. It's worth looking into.

SWIFT 11 X 80 Binoculars **$219**

Includes tripod mount and case. "Tremendous brightness."

TeleVue Eyepieces

Plossl	
55mm	$155
40mm, 32mm	89
26mm, 21mm, 17mm, 13mm	75
10.5mm, 7.4mm or 1.8x, 2.5x Barlow	75
Wide Field	Call
Nagler	
20mm Type 2	$289
16mm Type 2	249
12mm Type 2	219
13mm	205
11m	195
9mm	185
7mm	159
4.8mm	129

TeleVue Oracle 3 **$699**

560mm 3" f7.4 triplet APO objective. Spotting scope, finder scope or lens. ***(Special price!)***

We take pride in our service.
Free freight in U.S.
Most orders shipped within 24 hours.
30-Day Money-Back Guarantee.
Trade-ins and foreign orders welcome.
Call for estimate.
VISA and Mastercard accepted.

NORTHERN SKY TELESCOPES

NORTHERN SKY TELESCOPES, INC.
5667 Duluth St.
Golden Valley, MN 55422
Specialists in Telescope, Binocular and accessory selection.

AstroNews

The Race Is On: U.S., Soviet Plans for Mars Exploration

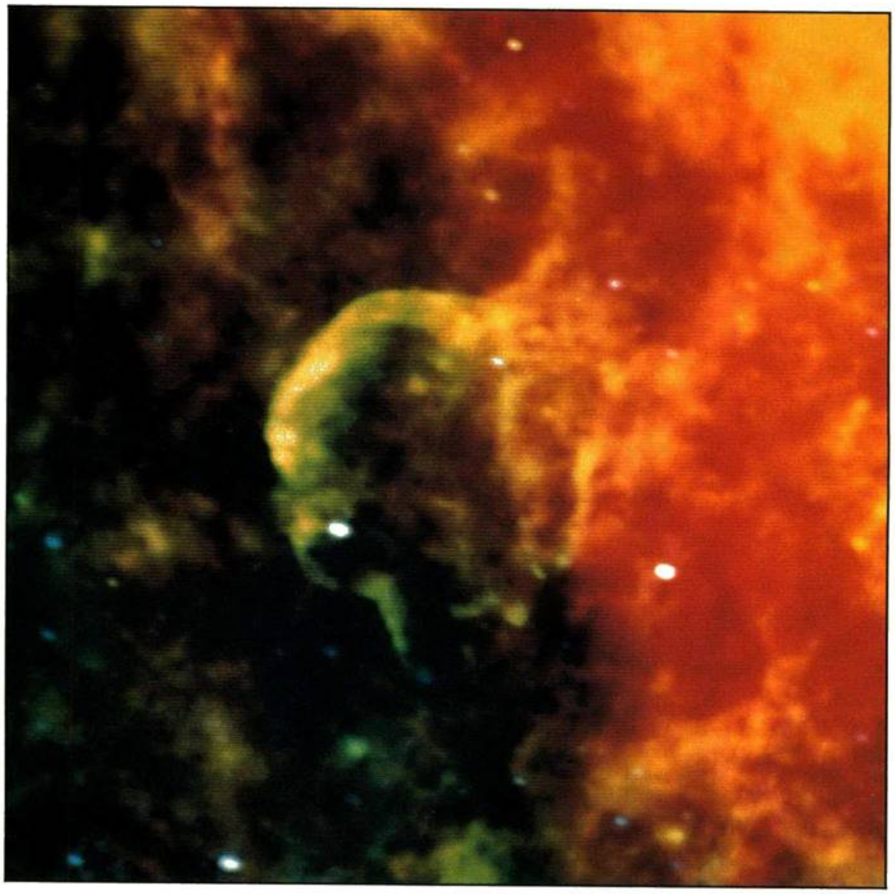
Ambitious Soviet plans for exploring Mars overshadowed a more modest United States proposal at the International Conference on Solar System Exploration held May 19-21 in Pasadena, California. U.S. officials said a sample return mission to Mars will revitalize NASA and restore U.S. leadership in space exploration. The Soviet program, however, features a far larger set of missions that will be completed before NASA's are.

R. Kremnev of the Babkin Center of Glavcosmos commercial launch vehicle marketing organization said the Soviet program will start with the 1992 launch of two identical pairs of helium-filled balloons and small solar-powered rovers supported by two orbiters. The rovers will have a 200-kilometer range and will map areas under consideration for the sample-return mission.

Two years after the launch of these rover/orbiters two much larger rover/orbiter combinations will be sent to gather samples over a larger area. In 1996 the rover/orbiters will rendezvous with two ascent vehicles designed to collect and boost the samples into Mars orbit. Return vehicles, launched separately from Earth in 1996 or 1998, will meet the ascent vehicles in Mars orbit and return the samples to a Soviet orbital space station near Earth, presumably the *Mir* complex currently under construction.

B. G. Lee of the Jet Propulsion Laboratory said NASA is beginning a major research and development effort to find the most cost-effective way to obtain samples from Mars. "We will not get to a 1996 launch without a major commitment within the year. That's not going to happen, so today we're looking at a 1998 or 2000 launch."

David Morrison of the University of Hawaii reviewed NASA's Solar System Exploration Committee recommendations to produce inexpensive, production line spacecraft. Although NASA approved this program seven years ago, only two Observer spacecraft for exploring the inner solar system are under construction; the Mariner Mark-II outer solar system spacecraft are being developed, though no flights have been approved. "It is not clear how long we can afford to march in place without a mission," said Morrison.



The Veil Nebula in Cygnus shows the first evidence of dust in a supernova remnant, an unexpected discovery. The blast wave from the explosion of a massive star some 10,000 years ago plowed through interstellar dust, and the shock front at the outwardly expanding edges of the blast created a shell of dust in and around the expanding supernova remnant. Astronomers Robert Braun of NRAO; Eli Dwek, Robert Petre, and Andrew Szymkowiak of NASA's Goddard Space Flight Center; and Walter Rice of Caltech discovered the dust shell by studying infrared observations made with the *Infrared Astronomical Satellite*. The astronomers can already state that "dust overrun by the [supernova's] blast wave dramatically affects the amount of radiation emitted by a supernova remnant." The image is a three-color composite showing 25-micron (blue), 60-micron (green), and 100-micron (red) wavelengths. The dust shell can be seen most easily at 60 microns. NASA photo.

Kremnev said the Soviets will use a new, production line interplanetary spacecraft. The 1988 *Phobos* mission to the Martian moons will be the first to use the new spacecraft. Although Kremnev admitted the Soviet mission will be difficult to accomplish, he said very little research and development will be needed, and the mission would use largely existing and proven equipment.

The conference was sponsored by the American Institute of Aeronautics and Astronautics and the Jet Propulsion Laboratory. — *Donald F. Robertson.*

Six Shuttle Flights Planned for 1988-89

NASA will launch six shuttle flights in the first year of resumed operations, according to a recently released schedule. These flights will include the launch of the Hubble Space Telescope and the *Magellan* mission to Venus. The first launch is scheduled for June 2, 1988.

The first mission, STS-26, is the launch of a *Tracking and Date Relay Satellite* /Inertial Upper Stage payload by *Discovery*, which was the originally scheduled mission for this date. (*Challenger* was carrying a *TDRS* when it exploded in January 1986.) On the shuttle's second mission *Atlantis* will carry a payload for the Defense Department. This mission is scheduled for September 8, 1988.

The third flight is scheduled for November 10, though the Kennedy Space Center would like to delay it until December 1. This mission is the launch of a Defense Department/Central Intelligence Agency advanced imaging reconnaissance satellite by *Columbia*.

A second *TDRS* spacecraft will be launched on February 2, 1989, followed by the *Magellan Venus Radar Mapper* spacecraft on April 25. *Magellan* replaces the Space Telescope as the fifth shuttle mission.

The sixth mission will be the launch of the Hubble Space Telescope, scheduled for June 1, 1989.

Until next June NASA will be testing a shuttle escape system that uses tractor rockets to pull astronauts from a disabled shuttle and completing mechanical and extraction rocket firing tests. The decision to use a rocket escape system has not yet been made, but NASA can delay the decision until May 1988 and still have time to install the system on *Discovery* for its first flight in June.

Polar-Ring Galaxies Yield Cosmological Insights

Polar-ring galaxies result from close encounters or mergers between galaxies, say astronomers at the Space Telescope Science Institute. Recent studies on the structure and dynamics of these rare galaxies are giving scientists the opportunity to study galaxy formation and the distribution of dark matter in the universe.

Polar-ring galaxies are characterized by a ring of stars, dust, and gas encircling the galaxy's poles at nearly right angles to the galactic plane. Nearly two dozen polar-ring galaxies have been cataloged, but they are difficult to study because they are distant and faint.

Using data gathered during observations of three polar-ring galaxies at Cerro Tololo Interamerican Observatory in Chile, scientists from the Space Telescope Science Institute (STSI) and the Carnegie Institution also studied the ring material to probe the gravitational field of these galaxies and deduce the presence and distribution of "dark" matter.

Brad Whitmore and Douglas McElroy of STSI and Francois Schweizer of Carnegie were looking for faint material beyond the rings, which would indicate a recent gravitational encounter with another galaxy. Images of two galaxies — NGC-4650A and ESO 415-G26 — made with a charge-coupled device revealed a faint shell of stars beyond the ring of each galaxy. Material existing that far from the galactic plane indicates that some sort of interaction with another galaxy took place.

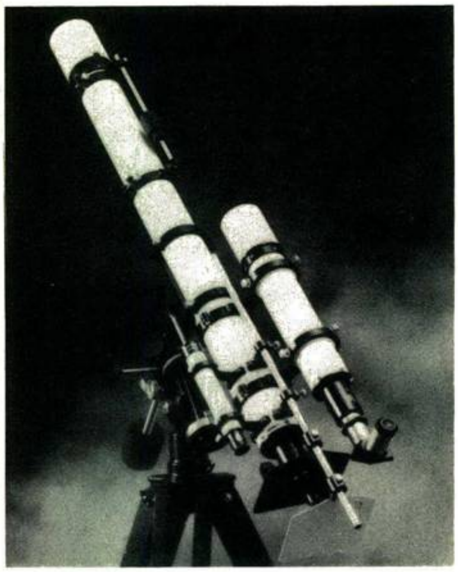
There are at least two ways galaxy interactions could have formed polar-ring galaxies. Material from one galaxy could have been drawn off into the outer regions of another nearby galaxy. There some of the extracted material could form faint shells. Most of the material, though, would fall into a polar orbit outside the disruptive influence of the galaxy's gravitational field.

Another possibility is that a small galaxy passing very close to a large galaxy could be completely pulled apart by tidal forces between the two systems. If the disintegration occurred over the pole of the larger galaxy, the stars, dust, and gas from the smaller galaxy might gather into a polar ring.

"Polar-ring galaxies provide more fuel for the theory that galaxies did not form in 'splendid isolation' but result from the interactions and mergers of two or more galaxies," says Whitmore.

Polar-ring galaxies also provide researchers with a way of studying the distribution of dark matter. Over the past ten years astronomers have shown that most galaxies do not rotate as if most of their mass were concentrated at the core — with stars rotating slower the farther they are from the core. Instead, stars near the edge of the galaxy are moving at about the same speed as those closer in, which suggests that they are being influenced by some dark mass beyond the galaxy's visible boundary.

Because polar-ring galaxies have stars distributed far above and below their disks, astronomers can study the shape of a galaxy's gravitational field by measuring



TRAVEL THROUGH THE UNIVERSE WITH UNITRON

Designed to the highest optical standards, Unitron refractor telescopes and accessories combine diffraction-limited optics with expert mechanical craftsmanship. The results are superior resolution per inch of aperture, unparalleled performance even under inferior viewing conditions, and optimal definition along an unobstructed light path. All of Unitron's telescopes are backed by a full 25 year warranty. For our complete catalog of telescopes, spotting scopes, binoculars, and other fine optical instruments send in coupon below.

UNITRON
EXCELLENCE BY DESIGN™
SINCE 1952

Please send me Unitron's catalog.
I enclose $5.00 for postage and handling.

UNITRON, INC. Leisure Products
175 Express Street,
Plainview, N.Y. 11803, U.S.A.
Tel. (516) 822-4601
A

Name ______
Address ______
City ______ State ______ Zip ______

ENJOY ASTRONOMY AT DOWN TO EARTH PRICES

$18 VALUE **FREE** $18 VALUE
focus ASTROPACK
- Guide to Astronomy
- Astrophotography Basics by Kodak
- Professional Optical Maintenance Kit

w/Purchase of Any Telescope

focus
CAMERA INC.
4419-21 13th AVE.
BROOKLYN, N.Y. 11219

FOR ORDERS ONLY
CALL TOLL FREE
800-221-0828
INFORMATION 718-436-6262

Ask for **HELEN, PHIL** or **MARK**,
our **TELESCOPE EXPERTS**

FOCUS CAMERA has been serving customers nationwide with all their photographic & astronomical needs for over 17 years. We invite you to join our thousands of satisfied customers. Call our knowledgeable sales staff **TODAY!** and **SAVE!!**
SATISFACTION GUARANTEE: Refund or Exchange within 14 days (less shipping) if returned in original **MINT CONDITION** intact with all papers as shipped.

Authorized Dealer **Meade**® THE LEADER'S EDGE **TELESCOPES** & ACCESSORIES

2080 SERIES
SCHMIDT-CASSEGRAIN TELESCOPES
2080 LX3
- Best Seller Astronomical Telescope for the Serious Amateur
- **Quartz Electronic LX Drive**
- Tremendous Light Gathering Capacity
- **Multi-Coated Silvered Optics**
- **AC** or **DC** Operation
- Supplied w/Ultra-Precise Drive System to Automatically Track Astronomical Objects

Outfit includes Star Diagonal, 2 Eyepieces
Super Plössl 9.7mm & 26mm &
8x50 Illuminated Finderscope
ALL THIS ONLY $1349^80

2080 LX2 Complete **w/Electric Drive** **High Transmission Coatings** **Limited Quantities** **$1069**
2 Eyepieces & 8x50 Finderscope
2080 8" Telescope w/**High Trans. Coating** 889
2080 LX5 NEW! w/2" Visual Back DC Oper. North/South Operation **CALL**
2120 LX5 NEW! The Ultimate 10" Telescope **CALL**

NEW **MTS SCHMIDT CASSEGRAIN**
SC8 8" f/10 With **6x30 Finderscope** Diag. Prism, **25mm Eyepiece,** Per Mount **$769**
SC8 MCOG As Above w/Silvered Optics **$854**
SC10 10" Schmidt Cassegrain **$1299**
#788 Motor Drive f/Mts 119.80
#790 **LX3 Quartz Drive** 419.80

Meade **RICH-FIELD NEWTONIAN REFLECTORS**
MEADE 8800 8" REFLECTOR
W/Full Equatorial Mount, Slow Motion Controls, 2 Oculars, 102X Power
- Full Length **Tripod** • **Sky Maps**
- **Camera Adapter** 1¼" • 6x30 Finderscope
- **Astrophotography Basics** & Eclipses

9-PIECE OUTFIT VERY SPECIAL **$834** ($1490 Retail)
6600 6" Newtonian Reflector Finder, Equatorial Mount & Tripod **LOW PRICE**
8800 8" Reflector w/Tripod **799**

CELESTRON®
POWERSTAR C8
Complete w/Starbrite Coatings
MicroProcessor Quartz Drive,
8x50 Finderscope, 26mm 1¼ Eyepiece,
Northern or Southern Hemisphere
Drive, **Wedge, Tripod**
& **Wheels, Dew Shield**
COMPLETE FACTORY PACK **$1569**

POWERSTAR C8 ACCESSORIES

DEC Motor	**48.90**	Focus Motor	**99.00**
AC Adapter	**17.25**	Car Batt. Adapt.	**17.25**
Rechargeable Batt. Set	**28.90**		

SUPER C8 PLUS w/SPECIAL COATINGS
17-Piece Outfit w/7mm & 26mm Oculars, 8x50 Finderscope etc. As Supplied By Manufacturer **LIMITED SUPPLY** **847^90**
SUPER C8 PLUS w/STARBRITE COATING **1179^80**
C8 Tripod **198** C8 Wedge **77**
SUPER POLARIS C8 11-Piece Outfit w/Tripod, Limited! **895**
SPC8 STARBRIGHT As Above **1029**
C11 STARBRIGHT **3199**

LIMITED QUANTITIES
FIRSTSCOPE 80 **6-Piece Outfit**
80mm Ultra-Sharp Optics
410mm Focal Length, Complete w/35X
Eyepiece, 1¼" Star Diagonal
Alt-Azimuth Mount w/Slow Motion
Controls, Field Tripod w/Tray **$369**

C80 **80mm Equatorial Refractor** w/Finderscope, 36X & 152X E.P., Tripod **ONLY FIVE PIECES LEFT!** **$399**
SPC80 w/Super Polaris Mount **CALL**
SCP6 **6" Newtonian,** 750mm f/5 Optics Super Polaris Mount, Complete **$695**
CO-60 COMETRON REFRACTOR, Best Value, w/2 Eyepieces & All Accessories **78^70**
COMETRON 50 Solid Brass, Executive Style w/Pedestal, 40 Power **168**

NEW **MTS SCHMIDT-NEWTONIANS**
SN6 **6" f/5 Schmidt Newtonian Reflector** w/Pier Mount, Legs, 25mm Eyepiece **$529**
SN6 MCOG As Above w/Silvered Optics **$589**
SN8 **8" f/4** Schmidt Newtonian Reflector **$779**
SN8 MCOG w/Silvered Optics **CALL**
#66A Declination Control 6" **$49**
6x30 Finderscope **$49**

DEEP-SPACE TELESCOPES
DS-10A 10" f4.5 Ultra-Sharp Reflecting Telescope w/Motor Drive, Setting Circles and Deluxe Focuser **$839**
DS-16A 16" Reflector. Gathers 4 Times as Much Light as an 8" Scope! Includes Motor Drive, Focuser & 1¼" Eyepiece **$1789**

Meade SPOTTING SCOPES LIFETIME WARRANTY
A WHOLE LOT MORE THAN MEETS THE EYE!
97D **w/5X24 Viewfinder,** Astro Photo Book Metal System Carry Case **$307**
- 1000mm Effective Focal Length
- 49X More Brightness Than The Human Eye
- 40X & 83X Eyepieces Included

97ER Erect Image (Right-Side Up) Black Rubber Covered Spotting Scope **397**
107D w/40X Ocular, 1000MM Effect, 4" w/Finder **CALL**
107D w/Photo Tripod **387**
PATHFINDER 15X-60X Zoom, 14 Elements, Razor Sharp. **242**
Same w/Rubberized Coating **309**

MEADE REFRACTORS:
310 3.1" 80MM F11, 1¼" Accessories **384**
320 3.1" 80mm Equatorial **$539**

Meade ACCESSORIES:

#38 Dec. Motor (2080 LX3)	**86**	#36 Control	**87**
#38A Dec. Motor (2045)	**86**	#43 RA Motor (MTS)	**88**
45° Erect Prism 1¼"	**44**	#1200 Elec. Focus	**152**
Dew Shield (2080, MTS SC8)	**58**	**T-Adapter** (MTS SC8, 10)	**39**
Illuminated Reticle	**85**	Tele Extender	**29**
Camera Adapter	**34**	**Other MTS Acces.**	**CALL**

Meade EYEPIECES:

Super Plössel 1¼" 6.4, 9.7, 12.4, 15, 20, 26mm	**74.50**	**Superwide** 1¼" 13.8, 18, 24.5, 32, 40	**From $113**
Barlow Lens 2X, 2.8X	**73**		

COMET CATCHER JR.
5-Inch, 1000mm Reflector
320X Light Gathering
Than The **Human Eye!**
w/40X Eyepiece & **6X30 Finder**
PERFECT BEGINNERS SCOPE!
SUMMER SALE! $147
Deluxe Tripod f/Com. Cat. Jr. **57**

COMET CATCHER **5.5" Richfield** Schmidt-**Newtonian, F3.6** Optics
Complete with 18mm 1¼ Eyepiece **$248^00**

C90 SPOTTING SCOPE
- Powerful and Versatile
- Can Be Used as Telescope or Telephoto Lens
- 159X The Light Gathering Ability of the Human Eye

$20^00 OFF Tripod w/Purch.

C90 7-PIECE OUTFIT INCLUDES:
- 30mm Ocular • Finderscope • Hi-Tech BLACK • Carry Case
- 18mm Ocular • Star Diagonal • Accessory Catalog • Lens Cap

C90 ASTRO **488** **SUPER C90** **409**
C90 Rubberized w/Tough Rubber Coat. Uses 1¼" Acces. **434**
SS-50 Spotting Scope w/20X, Hi-Tech Black **Special** **79**
Photographic Tripod For **C90, Special** **68**

ACCESSORIES

Accessory Case	**29.50**	LPR #1	**109**
Barlow **2, 2.5, 3X** • 96"	@ **33**	LPR #3, 4	@ **67**
Barlow **2X, 3X** 1¼	@ **41**	**Optics Cleaning Kit**	**27**
Counterweight Bar ASS. 8"	**95**	Porro Prism • 96"	**29**
DC Inverter	**98**	Porro Prism 1¼	**37**
Dewstar/Shield 8"	**25.70**	Rich Field Lens	**28**
Drive CRCTR (SA) SPC	**127**	Sky Maps	**14**
EP Filter Set • 96"	**52**	**Sky Sensor**	**LOW PRICE**
EP Filter Set 1¼"	**72**	Sky Filter #1 (C90)	**35**
10X40 Finder C8	**112**	Sky Filter #2 (C8)	**38**
Illum Reticle 1¼"	**157**	Tele Extender	**28**
Image Corrector 1¼"	**38**	Wedge (C90)	**77**

EYEPIECES:

Orthoscopic • **96"** 4, 5, 7, 9, 12mm	@ **41**	**Plossel 1¼"** 7.5, 10, 15, 17, 22, 26, 36, 45mm	@ **67**
Orthoscopic 1¼" 4, 5, 6, 7, 9, 12, 18, 25mm	@ **42**	**Erfle 1¼"** Wide Field 16, 20, 24, 28, 32mm	@ **54**

BAUSCH & LOMB CRITERION
4000 ASTRONOMICAL OBSERVATORY TELESCOPE
BUY SOMETHING WORTH LOOKING INTO!
- Compact 7"x7"x14" weighs 10 lbs.
- Includes Finderscope, 2 Oculars & Adjustable Legs
- 1200mm Effective Focal Length
- With Electrical Clock Drive

9-Piece Outfit **$443**
BAUSCH & LOMB 4000 PRO Observatory Telescope w/2X Barlow, Camera Mount and Enhanced Optical Coating for 20% Greater Light Transmission **499**
B&L 4000 Spotting Scope w/30X & Porro Prism **335**
CRITERION 3000 Spotter NEW! **189**

CRITERION 8001 OBSERVATORY
- 8" Aperture
- 2110 MM F/10 Focal Length
- 480X Magnification
- 2 Oculars
- Deep Sky Guide
- 8x50 Finderscope

999

NEW **CRITERION 6000 PRO** Astronomical 6" Scope **10-PIECE OUTFIT**
As Above w/6" 1400MM Focal Length **CALL**

TELESCOPE ACCESSORIES:

Wedge (4000)	**68**	Wedge (6000/8000)	**78**
Field Tripod (4000)	**132**	Field Tripod (6000/8000)	**190**
Porro Prism (4000)	**38**	Nebula Filter	**63**
2X Barlow Lens	**28**	Counterweight Set	**39**
Solar Filter (4000)	**97**	Video C-Mount	**32**
4000 Astro Photo Kit (4 Pcs.)	**69**		

NEWTONIAN REFLECTORS
4.5" Reflector w/Tripod & • 96" E.P. **329**
RV-5 + w/Tripod Equatorial Mount Finderscope & 3 1¼" Eyepieces **649**

BAUSCH & LOMB
Discoverer Zoom Telescope
Spotting Scope w/15X-60X Zoom **189**

ASTRO TELESCOPES

#5400 155X Magnification, w/Finderscope & Tripod	**99**	Camera Mount	**18.90**
#5500 Same w/280X Magni.	**124**	Bushnell Discoverer Case	**26**
#5100 Features 400X Magni.	**159**	Car Window Mount	**34**
		Proff. Photo Tripod	**59**

SPACEMASTER®
PRISMATIC TELESCOPES **4-PC. OUTFIT**
- SPACEMASTER 60MM
- 15-60X Zoom Eyepiece
- Mini Tripod
- Attaché Case

217

SPACEMASTER #1800 **145** Camera Mount **27**
Eyepiece **35** Zoom **75** Wide-Angle **42**
#2300 **45°** SPACEMASTER **178** Case **19**

GIANT BINOCULARS
CELESTRON® PRECISION OPTICS **UNITRON**® **Meade**
- Perfect for Astronomy & Low Light Viewing
- Glare-Free Viewing & No Eyestrain
- Exceptional Image • 25 Yr. Warranty

11x80 **209** 20x80 **229**
30x80 **CALL**
16x70 Astro Observation **323**
20x80 Deluxe Multicoated w/Sliding Rail. **415**
11x80R **Rubberized** **239** 20x80R **Rubberized** **259**
Tripod Adapter **18.90**

NEW **ASTRONOMICAL** SOFTWARE BY ZEPHYR
ASTROCALC- The Easy Way To Do Those Difficult Calculations **29.90**
ASTROSTELL- View the Constellations & Their Treasures **29.90**
ASTROBASE- A Data Base For Astronomers **29.90**
ASTRO-AID- Gives You The Answers **29.90**
COMETWATCH Complete Details About Comets **29.90**
Available For IBM, Apple & Commodore C64/128
BONUS BUY ANY TWO PROGRAMS **SAVE 10%**

Nikon **SPOTTING SCOPES & BINOCULARS**
The Famous Nikon Optics Are Your Best Assurance For Clear And Crisp Images
NIKON SPOTTING **SCOPE w/20X** **247**
Nikon Spotting Scope **ED** **CALL**
Photo Attachment **114**
7x50 Center Focus 'Starview' **133**
7x35 CF w/25 Yr. Warr. **79**
7x50 Tropical **197** 10x70-IF **378**
8x23-CF **75** 10x50 Sentinal **153** 12x36D **227**

Bushnell BINOCULARS

BAUSCH & LOMB SERIES:		**BANNER SERIES:**	
7x35 CF #61-2010	**209**	7x50 Instafocus	**74**
10x50 CF Standard	**224**	10x50 Wide	**77**
7x24 **149** 8x24	**159**	8-24x50 Instafocus Zoom.	**136**
EXPLORER SERIES:		**SPORTSVIEW:**	
7x50 Insta-Focus	**114**	7x35 Extra Wide Angle	**44**
8x40 Wide Angle	**114**	7x50 **45** 10x50	**50**
10x50 Wide	**119**	8x40 Wide **52** 16x50	**58**

focus CAMERA
4421 -13th Ave.
Brooklyn, N.Y. 11219
ORDERS: 800-221-0828
INFORMATION: 718-436-6262
CUST. SERVICE: 718-871-7608

Orders Shipped Promptly—Mastercard, Visa & **Discover** gladly accepted. You may use your American Express card. No surcharge on Mastercard, Visa or **Discover.** Please add estimated charge for shipping, handling & insurance. Written inquiries welcome. Not responsible for typographical errors. HOURS: Mon-Thurs 10-7, Fri 10-4, Sun 10-6. All merchandise available at prices shown while supplies last. This ad supercedes all other ads.

All Telescopes Include Full U.S.A. Warranty, and are Shipped Complete as Packaged by the Manufacturer.

how fast those stars are orbiting. Whitmore, McElroy, and Schweizer found that stars in polar rings orbit with the same velocities as stars in the disk, which indicates that the polar-ring stars are also under the influence of "invisible mass." They conclude that dark matter is distributed in a vast spherical shell around these galaxies rather than in a flattened disk.

The shell of dark matter around a polar-ring galaxy extends outward at least three times the diameter of the galaxy's luminous disk. If this matter is evenly distributed around the galaxy, then the unseen matter fills a volume of space that is about twenty times greater than that occupied by the visible galaxy.

Solar Waves Cause Aurorae

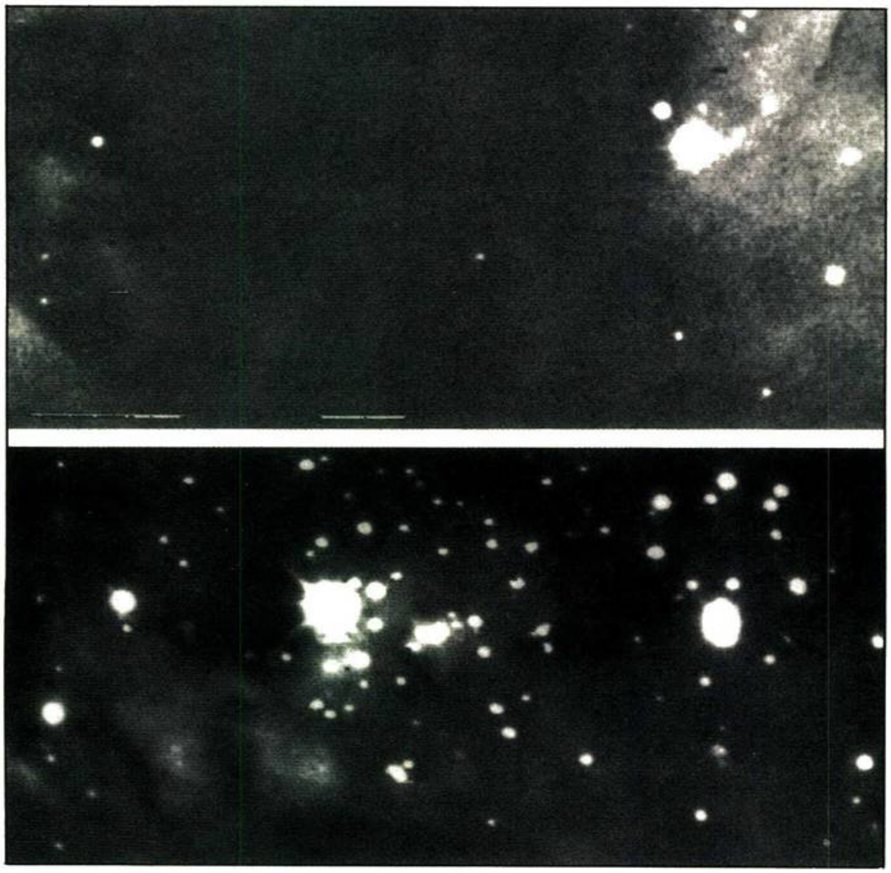
The traditional view of aurorae as a result of magnetic storms triggered by solar disturbances is not correct, according to research by two Jet Propulsion Laboratory scientists.

Working with data gathered nine years ago by the *International Sun Earth Explorer-3* satellite (later renamed the *International Cometary Explorer* and used to examine the comet Giacobini-Zinner in 1985), Bruce Tsurutani and Walter Gonzalez contend that aurorae are caused by Alfven waves, magnetic waves generated by the Sun's magnetic field.

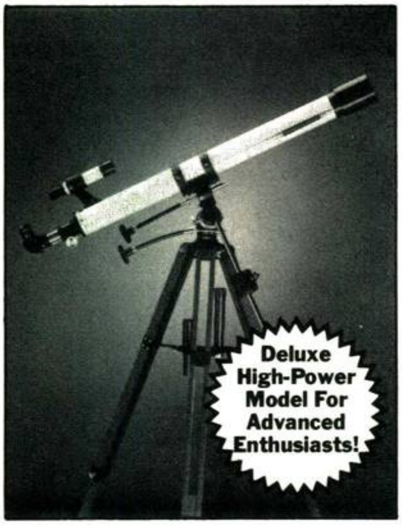
The waves move out into the solar system, causing directional changes in the interplanetary magnetic field. If the directional change is opposite to the northward direction of Earth's magnetic field, a magnetic interaction occurs and the two fields connect.

"The interplanetary magnetic field that originates with the Sun connects with the Earth's magnetic field and pulls the field in the downstream direction away from the Sun," Tsurutani explains. "This magnetic field reconnects behind the Earth and causes charged atomic particles to slingshot toward the night side of Earth."

When the plasma draws near Earth, the particles scatter, and the ions and electrons follow the magnetic field lines of Earth toward Earth's surface at both poles. Collisions between these incoming particles and atoms in the upper atmosphere excite the atoms, causing them to radiate in the characteristic red and green light of



It's possible that inside every dark cloud of dust in the universe lies a stellar nursery. A new infrared detector being tested by the National Optical Astronomy Observatories sees through these optically opaque clouds as if they were transparent. In visible light (upper image) the nebula NGC-2024 in Orion looks like empty sky with some stars along the edges. But seen with the new infrared detector at a wavelength of 2 microns (lower image), the cloud appears to harbor many young stars. The new detector uses an array of four thousand sensors rather than a single sensor. This permits astronomers to image whole areas of the sky within minutes instead of having to construct images one painstaking data point at a time. NOAO photo.


COMB
Authorized Liquidator

FAMOUS MAKER 454x TELESCOPE

Focus on This Deal...a precision Equatorial Refractor Scope by a famous maker! Now discontinued, this factory new model is at a **LOW liquidation price.** We can't print the name brand. But if you call Toll-Free 1-800-328-0609, we can TELL you.

- Fully Coated Optics for Crisp Astronomical Views. A 1.5 Image Erecting Lens Converts Telescope for Terrestrial Use.
- 910mm Focal Length, 60mm Aperture.
- Wide Angle 6x30 Finderscope.
- Includes 43x, 76x, 227x Eyepieces, Plus Barlow 2x Lens Which Doubles the Power of Any Eyepiece.
- Star Diagonal Prism for Celestial Views.
- Precision Equatorial Mount with Slow Motion Controls and Setting Circles. Moon Filter. Sun Projection Screen. 5-ft. Wooden Tripod. Lighted Accessory Tray.

Mfr's. Ltd. Lifetime Warranty.

Mfr. List Price....... $460.00

Liquidation Priced At $159

Item H-3068-7167-521 S/H: $9.00 ea.

Credit card members can order by phone, 24 hours a day, 7 days a week.

Toll-Free: 1-800-328-0609

Sales outside the 48 contiguous states are subject to special conditions. Please call or write to inquire.

SEND TO: **Item H-3068**
C.O.M.B. Direct Marketing Corp.
1405 Xenium Lane N/Minneapolis, MN 55441-4494

Send___**454x Deluxe Telescope(s)** Item H-3068-7167-521 at $159 each, plus $9 each for ship, handling. (Minnesota residents add 6% sales tax. Sorry, no C.O.D. orders.)

☐ My check or money order is enclosed. (No delays in processing orders paid by check.)

PLEASE CHECK: ☐ VISA ☐ MasterCard ☐ DISCOVER ☐ AMERICAN EXPRESS

Acct. No. ________ Exp. ___/___
PLEASE PRINT CLEARLY
Name ________
Address ________
City ________
State ________ ZIP ________
Phone (____) ________
Sign Here ________

COMBCOMBCOMB

ODYSSEY
TELESCOPES
Seeing the *real* Universe

FREE INFORMATION
- ODYSSEY GUIDE
- OWNER COMMENTS
- REPRINTS
- DOBSONIAN INFO.
- COULTER OPTICAL NEWS
- PRODUCT LIST

ASK FOR IT!

8 inch $239.50

"On the Moon and Jupiter, the Odyssey 8 showed as much detail as several 8" Schmidt-Cassegrains nearby."
David McGough, Millington, N.J.

"It is worth twice what I paid, but please don't raise the price. I want to get my son one in a few years."
Tom Johnston, Boulder, Colo.

10.1 inch $299.50

"Careful star-testing of the 10.1" Odyssey Compact I received last March and of the 10.1" my neighbor Doug Barnes picked up in mid-October suggests a high level of quality control which is astonishing. Diffraction patterns are virtually interchangeable, and both scopes show textbook optical results (both in-focus and out-of-focus)."
Lee Johnson, Coquitlam, B.C. Canada

13.1 inch $499.50

"In amateur astronomy for over 35 years and I have seen my share of all kinds of telescopes, good and bad. To say the least, the Odyssey 1 outperforms anything that I have seen!!"
Richard Ziegler, Maumee, Ohio

"There is not another telescope of equal size in our club that can touch the clear image and ease of operation that Odyssey 1 provides."
Mark Davenport, Pinellas Park, Fla.

17.5 inch $995.00

"I've only had a chance to view once so far, but am thoroughly thrilled with it. Viewing from a (Santa Barbarà, Ca.) residential front yard, the Orion Nebula was indeed a treat – reddish tinges on the predominating green, with many subtle wisps and lanes very clear. The Andromeda Galaxy was surprisingly bright, as was its companion." David Broad, Santa Barbara, Ca.

Lightweight Mirror Optics at Low, Low Prices:
Pyrex, ⅛ wave, aluminized & overcoated

10 inch f/5.6	$129.50
10.1 inch f/4.5	$134.50
12.5 inch f/6	$249.50
13.1 inch f/4.5	$254.50
17.5 inch f/4.5	$590.00

Elliptical Diagonals
1.83" — $15.50
2.14" — $18.95
2.60" — $22.50
3.10" — $ 34.50
4.25" — $ 69.50
6.25" — $150.00

EASY TO ORDER . . . Phone or mail your order in today. Visa/MasterCard accepted. All telescopes are shipped freight charges collect. All mirrors are shipped prepaid in the contiguous U.S.A. No sales tax on out-of-state orders. Phone orders Mon-Fri 8 am-4:30 pm local time.
Call 1-714- 659-4621
- 30 days returnable
- 30 days exchangeable
- 2 years materials and workmanship

Coulter Optical, Inc.

P.O. Box K
Idyllwild, CA 92349-1107

"OPTIMUM OPTICS AT MINIMUM COST SINCE 1967".

an aurora.

The solar wind, say Tsurutani and Gonzalez, could also play a part in generating aurorae. This stream of charged particles that is constantly emitted by the Sun may initially be accelerated by Alfven waves.

"What we may be seeing," Tsurutani says, "are the remnants of the solar wind acceleration process striking the Earth's magnetic field and causing injection of the solar wind energy into the Earth's atmosphere."

New Palomar Survey Reveals More Detail

Since the release in 1954 of the National Geographic Society/Palomar Observatory Sky Survey — a photographic survey of the northern sky — films and telescope technology have come a long way. A new sky survey, currently under way with Palomar's 48-inch Schmidt telescope, has capitalized on these advances (see "The New Improved Palomar Sky Survey" by Tom Wilson, October 1986). The difference in quality between the two surveys is dramatic.

The photo from the old survey (below left) was taken with 103a-O Kodak glass plates. The photo from the new survey (right) was taken with Kodak's new IIIa-J spectroscopic film. The IIIa-type films have finer grained emulsions than the old film, which allows astronomers to record fainter objects and therefore more structural detail.

A new two-element corrector lens recently installed on the Schmidt telescope also improves the quality of the images by correcting light at two wavelengths. This broadens the telescope's spectral range so better images can be obtained, especially at the ultraviolet and infrared ends of the spectrum.

With the new Kodak film and the telescope improvements "we expect that we will see things — faint structures outside of galaxies — that previously went unnoticed," says Robert Brucato, assistant director of Palomar Observatory.

Caltech astronomers say they hope to gain new insights into the structure and evolution of the Milky Way, find thousands of new objects, and study the features of known phenomena in unprecedented detail.

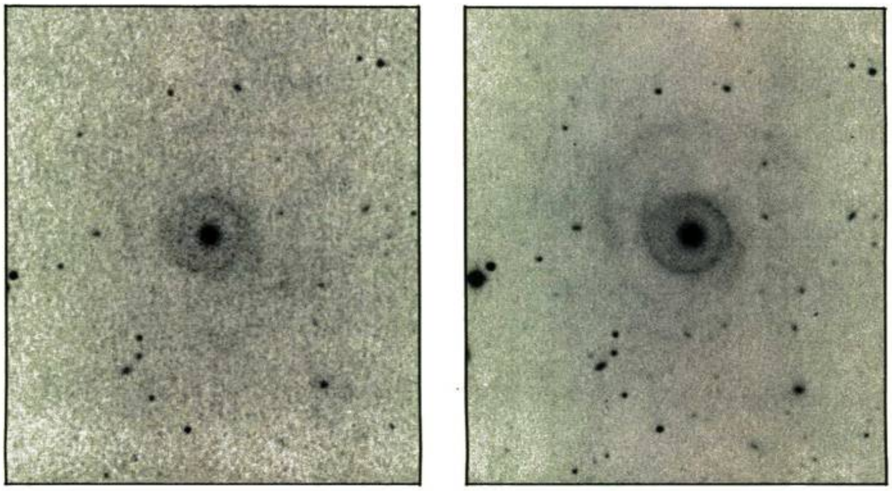
Binary Quasar Discovered

The first known double quasar has been found by a team of European and American astronomers with a combination of optical, spectral, and radio observations. Apparently associated with the radio source PKS 1145-071 in the constellation Crater, the quasar appears to have two faint, starlike components separated by 4.2". However, it is not a gravitational lens object, a single quasar seen as two images because a massive object lies along its line of sight.

The two images were first noticed on an image made with the European Southern Observatory's 2.2-meter telescope on December 29, 1986. Spectroscopic observations of the quasar made with the Multiple Mirror Telescope in Arizona on January 3 and 4, 1987, confirmed that both objects have quasarlike spectra and are 3,700 megaparsecs away.

The team of astronomers studying this peculiar object is made up of Stanislav Djorgovski of the Harvard-Smithsonian Center for Astrophysics, Georges Meylan of the European Southern Observatory, Richard Perley of the National Radio Astronomy Observatories, and Patrick McCarthy of the University of California.

At first the astronomers thought PKS 1145-071 might be an example of the so-called gravitational lens phenomenon, where the image of a single quasar is split into two by the gravitational field of a galaxy or cluster of galaxies lying in between the quasar and Earth. However,



Spiral galaxy UGC-6614 on plates from the old sky survey (left) and the new survey (right). Photos courtesy of Palomar Observatory, California Institute of Technology.

spectral observations indicate both images are "real," because the spectra are slightly different. Moreover, there appears to be a small but measurable relative velocity difference between the two quasar images. The strongest evidence that the two are distinct objects came from the Very Large Array telescope in New Mexico, which showed only one radio quasar in the field. A single object made to appear double by means of a gravitational lens would show two equally bright radio images.

From the measured velocity difference and the projected separation of the two quasars, astronomers estimate the pair has a mass of about 100 billion solar masses. Such masses are typical for normal galaxies, and this evidence supports the notion that quasars are the extremely bright, active centers of distant galaxies.

It is also possible that the quasars are members of an extremely distant cluster of galaxies. The mere existence of large galaxy clusters at such distances would place an interesting constraint on theories for large-scale structure in the universe, because it would mean that such clusters existed long ago. Future studies of galaxies in such clusters could be extremely useful clues to the nature of galaxy evolution and the early universe.

Tiny, Dusty Clouds Discovered in Milky Way

Our Galaxy contains hundreds of billions of very small clouds of ionized gas and dust never before observed, according to a paper in *Nature* (April 16, 1987). Astronomers at the Naval Research Laboratory (NRL), Virginia Polytechnic Institute, and Mullard Radio Astronomy Observatory discovered the clouds with a radio telescope and an interferometer in Green Bank, West Virginia. The astronomers, led by Ralph Fiedler of NRL, claim the discovery has "far-reaching implications concerning the content[s] of the Milky Way Galaxy."

The new clouds are very different from those we already know about: They are as small as the distance between the Earth and the Sun and may have only as much mass as an asteroid. There may be more of these tiny clouds in our Galaxy than stars. The old clouds, on the other hand, range in size from 10,000 to 20 million times the diameter of our solar system. The masses of these new clouds range from 2/10ths to 10,000 times that of the solar system.

Fiedler speculates that the newly discovered clouds may be part of a growing network of material ejected by supernovae. Theoretically each supernova explosion could produce many such clouds. Fiedler and his colleagues are planning experiments with other radio telescopes to learn more about the role these clouds play in our Galaxy.

The sky's the limit...
Astroscan® 2001
WIDE FIELD Telescope

Reach out and explore the night sky. Unique award-winning design allows you to cradle it in your arms or it glides smoothly and solidly into its table-top base. Highlights: of this scope are its extra wide 3° field and its superb light-gathering ability with large 4⅛" clear aperture to resolve panoramic vistas. Optional image erector adapts scope to view land objects. Focuses 25 feet to infinity. System is sealed to protect against dust and moisture, and is permanently collimated at the factory.

SPECIFICATIONS – Primary Mirror: 4⅛" (105mm) clear aperture f/4.2; 17½" (445mm) f.l. parabolic; Pyrex aluminized and overcoated; figured to ⅛ wave; factory precollimated and fixed. **Secondary Mirror:** Elliptical 1.5" minor axis; ⅛ wave flat; aluminized and overcoated. Diagonal support mounted to an anti-reflection coated optical window providing protection against moisture, dust and damage to optics. **Eyepiece:** 28mm e.f.l. RKE®; 45° field; standard 1¼" O.D. barrel. **Magnification:** 16X with 28mm RKE®; 75X with optional eyepieces and Barlow. **Field of View:** 3.0 degrees at 16X. **Focuser:** Positive-grip rubber roller type, 25 ft. to infinity. **Weight:** Scope weighs 10.75 lbs. Base is 2 lbs. **Body:** Special high-impact red plastic.

Astroscan® 2001: Includes telescope, base, 28mm RKE® eyepiece, finder sight, dust cap, carry strap, 10 pg. inst. book and 36 pg. sky guide. **2001 $329**

A wide assortment of accessories are also available.

For the name of your nearest Astroscan® dealer, or for a free copy of the Edmund Scientific full color catalog, call or write:
(609) 573-6250

SERVING ASTRONOMERS SINCE 1942
Edmund Scientific Co.
Dept. 2150, Edscorp Bldg., Barrington, NJ 08007

Meade

ADVANCE CAMERA
HAS IT ALL!
• LOW PRICES
• EXPERT SERVICE
• IN-STOCK ITEMS
• FAST DELIVERY
20 YEARS EXPERIENCE

MEADE CELESTRON
TELEVUE OCULARS
RENAISSANCE ORACLE 3

SPECIAL WITH THIS COUPON ONLY
Celestron Super C8+
With Special Coating
SUPER CLOSE-OUT SALE $995.
FREE Tripod & Wedge

SINCE 1947
ADVANCE CAMERA CORP.
15 West 46 St.
New York, NY 10036
212-944-1410
VISA MasterCard

ASTRO AUDIO TAPES TO SEE BY

FIELD GUIDE TO THE SOLAR SYSTEM
Your own Planetarium presentation
ANYTIME, ANYWHERE!

With the assistance from **NASA** and narration by **Albion Watts** you have the legends, history and current data of the world's oldest science in an audio format . . . unveiling the Solar System.

Four volumes - Each volume contains *two 1-hr.* audio-cassette tapes. Moisture-resistant. Dustproof case. Quality and Durability.

UNCONDITIONAL LIFETIME REPLACEMENT GUARANTEE

When books/videos are least useful, these tapes travel with you . . . into the night sky.

INTRODUCTORY OFFER
Purchase Vol. I - JUPITER and MARS at $29.95. and we'll pay shipping and handling.

[ ] Enclosed is my check/money order.
Or charge my [ ] VISA [ ] MASTERCARD
[ ] Please send additional information
CC # ______ Ex. Date ______
Signature ______
Name ______
Address ______
City ______ St. ______ Zip ______

Send to: ASTRO AUDIO COMPANY
P.O. BOX 543, 139 MAIN STREET
IVORYTON, CT 06442 (203) 767-0525

A-1

ASTRONOMY
AstroCalendar

Through September 27
Space Imagery Exhibit (celestial photography, space equipment, sponsored by the city of Lancaster Museum/Art Gallery), Lancaster, California. Contact: Norma Gurba, 44801 North Sierra highway, Lancaster, CA 95334. Phone: (805) 948-8655.

September 2-October 15
"25 Years of Space Photography" (140 photographs taken by unmanned spacecraft; organized by the Baxter Art Gallery at the California Institute of Technology and sponsored by IBM), Lowe Art Gallery, University of Miami, Coral Gables, Florida. Contact: Andrea Kirsh or Ira Licht, 1301 Stanford Drive, Coral Gables, FL 33146. Phone: (305) 284-3553.

September 18-20
8th Annual Astrofest (sponsored by the Chicago Astronomical Society), Camp Shaw-Waw-Nas-See, sixty miles south of Chicago, Illinois. Contact: Astrofest, P.O. Box 596-A, Tinley Park, IL 60477.

September 18-20
September Starfest (sponsored by the Southern Cross Astronomical Society, Inc.), Florida International University-Tamiami Campus, Miami, Florida. Contact: Southern Cross Astronomical Society, 690 Allendale Road, Key Biscayne, FL 33149. Phone: (305) 661-1375.

September 25-26
N.I.A.G. Fest '87 (sponsored by the Northern Indiana Astronomical Group: Warsaw, Michiana, and Fort Wayne societies). Holiday Inn, Warsaw, Indiana. Contact: Alan Mitterling, RR #3, Box 331A, Warsaw, IN 46580.

October 2-4
AstroAssembly 1987/Northeast Regional Astronomical League Convention (sponsored by Skyscrapers, Inc., the Astronomical Society of Rhode Island), Seagram Memorial Observatory, North Scituate, Rhode Island. Contact: Brian Magaw, Town Farm Road, P.O. Box 325, Pascoag, RI 02895. Phone: (401) 568-8424.

October 3-4
3rd Meteor Space Meeting, Amsterdam, Holland. Contact: Mark P. Traa, *Meteor* Magazine, Mosbeek 26, 5501 BD Veldhoven, Holland.

October 8-10
Great Plains Planetarium Association Meeting, Omnisphere Earth-Space Center, Wichita, Kansas. Contact: Jose Olivarez, Omnisphere Earth-Space Center, 220 South Main, Wichita, KS 67202.

October 15-18
Oklahoma Star Party (sponsored by the Oklahoma City Astronomy Club), Lake Murray, Oklahoma. Contact: OSP Registrar, P.O. Box 21221, Oklahoma City, OK 73156.

October 15-27
Joint Meeting of the Rocky Mountain and Pacific Planetarium Associations, Fleischmann Planetarium, Reno, Nevada. Contact: Arthur W. Johnson, Jr., Fleischmann Planetarium, University of Nevada, Reno, NV 89557.

October 18-31
Peru Revisited (three-part field trip sponsored by the Astronomical League). Leaves from Miami. Registration deadline: September 16. Contact: Cynthia Crittenden or Laura Stanley, Travel and Transport, St. Joseph, MO. Phone: 1-800-821-9010, in Missouri 1-800-892-9035.

October 23-25
9th Annual Astronomy Jamboree, Custer Institute, Southold, Long Island, New York. Contact: Tom Carey, Vanderbilt Planetarium, Centerport, Long Island, New York 11721. Phone: (516) 757-7501.

October 23-25
Deep South Regional Stargaze (sponsored by the Jackson Astronomical Association), Percy Quin State Park, McComb, Mississippi. Contact: Jeff Sommers, 414 Woody Drive, Jackson, MS 39212. Phone: (601) 982-2388 days, (601) 372-2275 evenings.

October 24
Astronomy Rendezvous and Conference 1987 (sponsored by the Twin City Amateur Astronomers), Illinois State University, Normal, Illnois. Contact: Carl J. Wenning, Physics Department Planetarium, Illinois State University, Normal, IL 61761-6901. Phone: (309) 438-8758.

October 29-31
Great Lakes Planetarium Association Meeting, Pierce Junior High School, Merillville, Indiana. Contact: Gregg L. Williams, Pierce Junior High School, 199 East 70th Avenue, Merillville, IN 46410.

AstroCalendar notices must be submitted at least four months in advance of the date of the event.

When contacting organizations that are sponsoring events, enclose a self-addressed, stamped, legal-size envelope for their response.

Planetary Programs and Tables from -4000 to +2800, by Pierre Bretagnon and Jean-Louis Simon. Re-create history's night skies and compute future positions of the Sun and planets. This book includes formulae, tables, and microcomputer programs in FORTRAN and BASIC to compute the longitude of the Sun, and the geocentric longitudes and latitudes of Mercury, Venus, Mars, Jupiter, Saturn, Uranus, and Neptune in the past, present, and future. 160 pages, paperback, #30135, **$19.95.**

ASTRONOMY SOFTWARE

Planetary Programs and Tables from -4000 to +2800
Pierre Bretagnon
Jean-Louis Simon
Foreword by Jean Meeus
ASTRONOMY WITH YOUR PERSONAL COMPUTER
PETER DUFFETT-SMITH
PRACTICAL ASTRONOMY WITH YOUR CALCULATOR
SECOND EDITION
PETER DUFFETT-SMITH
Astronomical Formulae for Calculators
SECOND EDITION
Jean Meeus
12566364
POCKET COMPUTER PROGRAMS FOR ASTRONOMERS
A COLLECTION OF 13 PROGRAMS FOR OBSERVERS, ASTRO-PHOTOGRAPHERS AND DOBSONIANS
FRED KLEIN
Celestial BASIC
Eric Burgess
Microcomputer Control of Telescopes
Mark Trueblood
Russell Genet
ORBITS FOR AMATEURS WITH A MICROCOMPUTER
A HALSTED PRESS BOOK
D.TATTERSFIELD

Astronomy With Your Personal Computer, by Peter Duffett-Smith. Contains 26 BASIC subroutines for calculating positions of planets, times of moonrise and moonset, circumstances of lunar and solar eclipses, positions of comets, and much more. Includes advice on how to apply subroutines to solve particular requirements. 256 pages, paperback, #30130, **$16.50.**

Practical Astronomy With Your Calculator, 2nd edition, by Peter Duffett-Smith. Tells you how to use a scientific calculator to convert local standard time to sidereal time, find the time of moonrise and set — and more. Assumes no specialized knowledge, provides complete examples. 188 pages, paperback, #30053, **$14.50.**

Astronomical Formulae for Calculators, 3rd edition, by Jean Meeus. For the more mathematically advanced, provides formulae for you to write programs to determine the positions of the jovian moons, the principal perturbations affecting the planets — and lots more. Fully worked-out examples. 201 pages, paperback, #30054, **$15.50.**

Pocket Computer Programs For Astronomers, by Fred Klein. Contains 13 Pocket Computer BASIC programs for calculating altitudes and azimuths, jovian satellite positions, age and phases of the Moon, comet positions, and much more. Besides the programs, it also tells you how the programs work so you can customize them for machines other than the Pocket Computer. 100 pages, paperback, #30055, **$12.95.**

Celestial BASIC, by Eric Burgess. Written for Apple II computers, but modifiable to run on other machines. Includes programs for precessing star coordinates, phases of the Moon on any date, and far more. Makes use of the Apple's graphics capability. 300 pages, paperback, #30056, **$18.50.**

Microcomputer Control of Telescopes, by Mark Trueblood and Russell Genet. This definitive volume describes both the theory and practice of operating a small- or medium-size telescope under full computer control. Covers control theory, motors, position sensing devices, the motions of the sky, control electronics and more. 300+ pages, paperback, #30065, **$19.95.**

Orbits for Amateurs With a Microcomputer, by D. Tattersfield. Designed for the small computer user, these programs (written in BASIC for the Timex/Sinclair 1000 and Radio Shack's PC-1 pocket computer) use no more than 16K of RAM at a time. They will compute an ephemeris for objects for which you have the orbital elements — or the orbital elements for objects for which you have positions. Has fully worked-out examples. 171 pages, hardcover, #30050, **$31.95.**

To order, use the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., 1027 N. Seventh St., Milwaukee, WI 53233. Include for postage and handling: U.S. $1; foreign $1.50. Wisconsin residents add 5% sales tax.

PHONE ORDERS ACCEPTED DAY OR NIGHT MON.-THURS. TILL 9:30 PM EDT, FRI. 9-2, SUN. 9:30-6

© 1987

ADORAMA

42 W. 18th St., New York, N.Y. 10011

SUSTAINING MEMBER

ORDERS & INFO
(212) 741-0052

STORE HOURS:
MON.-THURS. 9-6,
FRI. 9-2. SUN. 9:30-6

FOR ORDERS ONLY:
TOLL FREE OUT OF STATE
800-223-2500
HAWAII & ALASKA: 800-232-7662

Customer Relations: (212) 741-0466
(Mon.-Thur. 9-4:30 pm EDT, Fri. 9-2)

COMPLETE W/MANUFACTURER'S ACCESSORIES

CELESTRON®

PRECISION OPTICS

SCHMIDT CASSEGRAIN TELESCOPES

POWERSTAR 8" — *INCLUDES: STARBRIGHT COATING, BUILT-IN DRIVE CORRECTOR, DC OPERATION, WEDGE and DEW SHIELD* ... 1549.95

NEW POWERSTAR 8 II ... **Call**

ACCESSORIES FOR POWERSTAR

Dec. Motor	79.95	Focus Motor	99.95
AC Adapter	17.95	Car Battery Adapt	14.95
Rechargeable DC Power Pack	69.95		

NEW COMPUTER CTL'D
C8, C11, C14 . Call For Prices

C11 w/StarBright	3249.95
C14 w/StarBright	7299.95
C90 Astro Telescope	**Call**

SUPER C8 PLUS

SUPER POLARIS C8

Super Polaris C8	849.95
Super Polaris C8 w/Starbright Coating	959.95

SUPER POLARIS ACCS

Single Axis Drive	139.95
Dual Axis Drive	199.95
Sky Sensor	Call

SUPER C8 PLUS

Super C8 Plus Blk w/Starbright Coating, Wdg, Trpd	1399.95
Adjustable Tripod	199.95
C8 Wedge	79.95
S.Axis Drive Corr	129.95
D.Axis Drive Corr	219.95

REFLECTOR TELESCOPES

C102 5m Newtonian	349.95
Super Polaris 6-Inch Reflector (SP-C6)	674.95
Celestron Comet Catcher	256.95
Comet Catcher Equatorial Mount	299.95
Pulse Motor Drive fComet Catcher,C6	159.95

REFRACTOR TELESCOPES

Super Polaris C102 102mm Refractor	949.95
Super Polaris C80 Refractor	629.95

CAMERA DRIVE

For Northern Hemisphere	119.95
For Southern Hemisphere	129.95

SPOTTING SCOPES

C90 Spotting Scope	304.95
Super C90 Spotting Scope	404.95
NEW! Rubber Coated Super C90	439.95

CELESTRON C90 ACCS.

Barlow.96 2,2.5,3X	**Ea.** 32.95	Porro Prism .96	29.95
Ortho. 96 E.P	39.95	Series 5 Filter Set	49.95
Kellner .96 E.P	34.95	Skylight Filter #1	31.95
Zoom Ocular .96	54.95	Super C90 Conv. Kit	109.95
Delx Zoom .96 Ocular	74.95	Wedge C90	73.95
E.P. Filter Set .96	49.95	Fork Mount & Drive	399.95
Mult Ocular .96 Hold	69.95	Deluxe Lat Art C90	39.95

CELESTRON TELESCOPE ACCS.

Accessory Case	29.95	Mult Ocular Hldr 1¼"	109.95
ALT Azimuth Adapter	59.95	Off Axis Guiding Sys	169.95
Barlow 1¼" 2x,3x	**Ea.** 40.95	Piggyback Mt 8/11/14	39.95
Barlow 2" 2x	79.95	Polarizer Filter Assm	109.95
Deluxe Barlow 1¼" 2x	79.95	Polarizer Set 1¼"	49.95
Chrmstr (Filt Wheel)	107.95	Porro Prism 1¼"	38.95
Counterwt Bar Assm 8"	99.95	Rich Field Lens f/1¼" EP	29.95
Counterweight Set 8"	59.95	Rich Field Adapt RFA	119.95
DC Inverter	89.95	Rich Field 80 w/32 Erfle	379.95
Dewstar/Shade 8"	24.95	Series 6 Filter Set	54.95
10x70 Fndr C8 (Grabstar)	219.95	Solar Filter 8"	279.95
16x70 Finder C8	249.95	Solar Filter Off Axis f/8"	149.95
8x50 RA Pol Find C8	129.95	Slow Motion Control	39.95
Illum Reticle EP	94.95	Super Polaris 8" Mount	499.95
Illum Proj Reticle 1¼"	144.95	Sky Filter #2	39.95
Image Corrector 1¼"	36.95	2" Widestar Diagonal	109.95
LPR Filter #1	109.95	Twinstar (Dual Viewer)	234.95
LPR Filter #5 f/2" E.P.	119.95	Tripod Accs Tray	64.95
LPR Filter #3 7	69.95	Tele Extender	27.95
LPR Filter #4 1¼ E.P.	69.95	Tele Extender Ref, Newt	44.95
Eyepiece Filter Set 1¼"	69.95	Wide Star System	199.95
Eyepiece Filter Set 2"	74.95	Wheels f/Adj Tripod	59.95

CELESTRON EYEPIECES

2" Plossl, Ortho, Erfle, Kellner	134.95
7.5,10,15,17,22,26,30,36,45mm 1¼" Plossl	67.95
16,24,28,32mm 1¼" Erfle	56.95
4,5,6,7,9,12,18,25mm 1¼ Ortho	46.95
Zoom Ocular (8.4-21mm) 1¼" Ortho	79.95

WE ARE NOW AUTHORIZED
QUESTAR
DEALERS - CALL FOR PRICES

Meade

THE LEADER'S EDGE

SCHMIDT-CASSEGRAIN

2080 LX5 MC/OG

COMPLETE w/WEDGE & TRIPOD **CALL**

2120 LX5 w/MCGO
Complete w/Wedge & Tripod ... 2479.95

2080/LX5

LX5 ACCESSORIES

#39 Dec Motor	96.95
1200A Elec Focuser	140.

2080/LX3

w/MULTI COATED/SILVERED OPTICS GROUP (MCSO), COMPLETE WITH WEDGE & TRIPOD .. **New Low Price-Call**

LX TELESCOPE ACCS.

#36 Ctl Box	87.	#38 Dec Motor	86.
#1401 Tube Balance Wghts f/2080	86.95		
#1402 Tube Balance Wghts f/2120	94.95		

2080 / 2120 GEM

2080 Gem w/HTC Coating	699.95
2080 Gem w/MCSO Coating	Call
2120 Gem w/MCSO Coating	1849.95

GEM ACCESSORIES

8x50 Polar Illum Viewfinder w/Brkt	129.95		
#784 Quartz Drive	163.95		
DC Cord	31.95	AC Cord	34.95
#3000 Computer Control	1099.95		

2045

w/HIGH TRANSMISSION COATING, FORK MOUNT, CORD, SETTING CONTROL, SLOW MOTION CONTROLS, PRISM, 2 E.P., 5x24 FINDER, TABLE, TRIPOD & CASE ... 509.95

2045/LX3 w/Multi Coated Optics ... 709.95

2045 ACCESSORIES

4" Field Tripod & Wedge	239.95		
#43 Drive Corrector & AC/DC Conv	84.95		
#36 Control Box	86.95	Piggy Back Bracket	18.95
#38A Dec Motor	85.95	#126 2X Barlow	47.95
Ring Counterweight	49.95	#582 Dew Shield	49.95

MEADE ACCESSORIES

SERIES 4000 EYEPIECES

Super Plossl		Ultra Wide		Super Wide	
6.4,9.7,12.4,15, 20,26	69.95	4.7mm	129.95	13.8mm	109.95
32, 40mm	89.95	6.7mm	159.95	18mm	119.95
56mm (2")	159.95	8.8mm(1¼,2")	189.95	24.5mm	134.95
		14mm(1¼,2")	217.95	32mm (2")	189.95
Barlow 2X, 2.8X			72.95	40mm (2")	248.95

Series 2 Ortho 1¼ 4,6,12.5,18,25mm	49.95
Series 2 Modified Achromatic 1¼ 6,9,12,25,40mm	39.95
40mm 1¼ Extra-Wide Field MA	49.95

TELE VUE

PLOSSL

55mm 2"	Call
40,32mm 1¼"	Call
26,21,17,13, 10.5,7.4mm 1¼"	72.95

WIDEFIELD

40mm 2"	Call
32mm 2"	Call
24mm 1¼"	Call
19mm 1¼"	Call
15mm 1¼"	Call

NAGLER

20mm Type 2; 2"	Call
16mm Type 2; 2,1¼"	Call
13mm 2,1¼"	Call
12mm Type 2; 2,1¼"	Call
11mm 2,1¼"	Call
9mm 2,1¼"	Call
7mm	Call
4.8mm	Call

BARLOW

2X, 1.8X 1¼"	Call

ACCESSORIES

2" Star Diagonal	149.95		
Rich Field Kit (55 Plossl, 2" Star Diag., Adapter, Reducer)	299.95		
9mm Guide E.P	Call	E.P. Projection Adapter	Call
1¼ E.P. Adapter f/Questar	74.95		

ORACLE

New ORACLE 3-3" f/7.4
Apochromatic Tele.

The New ORACLE 3 is a high resolution, high contrast wide angle versatile scope.

CALL FOR OUR LOW PRICE

the RENAISSANCE™

4" f/5.5 Wide Field Tele	Call
RSM-2000 System Mt	399.95
RWD-2204 Wood Trpd	279.95
RAL-2201 Alum Trpd	174.95
RTR-2023 Tube Hldr Rings	80.

EDMUND SCIENTIFIC

Astroscan 2001	239.95

Edmund Scientific's affordable wide-field, go-anywhere telescope gives super bright images.

RKE Eyepieces	29.95	2.5 Rke Barlow	47.95
Orthoscope E.P.	41.95	Goodwin Barlow	21.95
		Roof Prism Image Erctr	54.95
		90 Prism Erector	29.95
		Vario Tube Cam. Adapt	41.95
		Tripod Bracket	27.95

Meade

NEW MTS TELESCOPES

MTS-SC8 8" Schmidt Cassegrain	769.95
MTS-SC10 10" Schmidt Cassegrain	1349.95
MTS-SN6 6" Schmidt Newtonian	529.95
MTS-SN8 8" Schmidt Newtonian	769.95
All MTS Telescopes are also available with Multi-Coated Optics Group	***Call For Prices***

MTS ACCESSORIES

#788 Drive	119.95	#790 LX3 Drive	419.95
#66A Manual Dec Control f/SN6, SN8	49.95		
#66C Manual Dec Control f/SN8, SC10	69.95		
#38M Electronic Dec System	109.95		
#43 Drive Corrector & AC/DC Converter	84.95		
6x30 Viewfinder w/Bracket f/SN6, SN8	49.95		
8x50 Viewfinder w/Bracket f/SN6, SN8, SC8	79.95		
8x50 Polar Illum Viewfinder w/Bracket f/SC8, SC10	129.95		
Off Axis Guider Assembly f/SN6, SN8	249.95		

REFLECTING TELESCOPES

6600" f/5	599.95	8800 8" f/4.5	799.95

DEEP SPACE TELESCOPES

D.S.-10A	849.95	D.S.-16A	1794.95

REFRACTING TELESCOPES

294 60mm f/15 Equatorial	314.95
310 80mm f/11 Altazimuth	394.95
320 80mm f/11 Equatorial	579.95
440/GEM 102mm f/10 Equatorial	1049.95

WIDE FIELD TELESCOPES

277 2.4" f/5 Refractor	119.95
622 6" f/3.6 Schmidt Newtonian	409.95

TELESCOPE ACCS.

Accs. Case #50	69.95	#910 Nebular Filter 2"	124.95
2X Barlow #122	44.95	#911 Nebular Filter	116.95
Carry Cs f/Tpd&Wdg	84.95	Dew Shield (2080)	59.95
Variable 2X,3X	59.95	Dew Shield (2120)	94.95
Rotary EP Holder 1¼"	113.95	Tele Extender	29.95
45 Erect Image E.P. 1¼"	44.95	Tele Compressor Sys	65.95
Wide Field Adapt Sys	119.95	8x50 Pol Illum Find	129.95
2" Star Diag	176.95	9x60 Polar Illuminated Finder w/Bracket	169.95
Off Axis Guider Assm	149.95	#43 R.A. Drive	89.95
Illum Reticle E.P.	83.95	#1200 Electric Focuser	151.95
Photo Visual Filt Set (6)	69.95	LED Map Light	27.95
#1A Sky Filter	44.95		
#908 Nebular Filter 1¼	58.95		

SPOTTING SCOPES

Pathfndr 15X60X Zoom	244.95	97E 3.5" Complete	349.95
97D 3.5" Complete	306.95	107D 4" Complete	349.95
Photo Tripod #77	69.95		

BAUSCH & LOMB

ASTRONOMICAL TELESCOPES

61-6800 8"	799.95
NEW 61-8001 8" Pro	999.95
61-6600 6"	739.95
61-6699 6000 Pro	789.95
61-6400 4" Observatory	444.95
61-6499 4000 Pro	499.95
61-6440 4000 Spotting Scope	269.95

ACCESSORIES

Pro Plossl 10, 17,26,35mm 1¼	57.95	63-1033 OffAxisGuider	129.95
4,6mm 1¼ Ortho	49.95	63-1020 RFT Assem	87.95
7,9,12.7,18,30mm 1¼ Symmetrical	34.95	63-1031 Nebula Filt	63.95
63-1052 Porro Prism	39.95	63-1088 Ser. 6 Filt Set	49.95
63-1016 2x Barlow	28.95	63-1030 Drive Corr	149.95
		Tripod & Wedge 4000	119.95
		Tripod & Wedge 6",8"	279.00

BAUSCH & LOMB DISCOVERER

78-1600 15-60x Spotting Scope	209.95		
22-3030 Camera Adapt	16.95	Car Window Mount	33.95

SPACEMASTER

78-7817 Standard w/Zoom EP, Tripod & Case	204.95		
78-2300 45 w/1 Std. EP & Camera Mount	174.95		
Camera Mount	19.95	Shooter Stand Trpd	27.95

NEW! SPACEMASTER II (70mm)

78-1900 Spacemaster II	119.95		
15,20,25,60X Eye Pieces	@ 36.95		
22X W.A.	41.95	15-45X Zoom	79.95

ADORAMA EYEPIECES & ACCS

Portable Recharg DC Pk	69.95	2" to 1¼ Adapt	24.95
Pelican Astro Mity Lite	16.95	1¼ to .96 EP Adapt Sys	17.95
1¼ Ortho 6,9,12.5,18,25	39.95	.96 to 1¼ EP Adapt Sys	16.95
1¼Plossl 10,13,17,24,36	54.95	.96 Ortho 4,6,9,12.5 20,25mm	29.95
1¼ Plossl 32mm	49.95	.96 Barlow 2x,3x	29.95
1¼ Star Diag	29.95	2" E.P. Filter Set (6 pcs)	69.95
1¼ Barlow 2x,3x	@29.95	2" Moon Filter (Polarizer)	19.95
Rubber Eye Grd f/1¼EP	6.95		
Vari Cam. Adapt 1¼or.96	27.95		

WE WILL ALSO BUY OR TRADE YOUR OLD TELESCOPE

MOST ORDERS SHIPPED WITHIN 48 HOURS

No Surcharge for MasterCharge or Visa Purchases. Personal checks welcome, will ship without delay. Name must be imprinted on check, also include address, phone, and a copy of major credit card or drivers license for reference. Shipping Charges: $5.95 + over 3 lbs. 50¢/lb., + over $750.00 2% of value. 14 day money back guarantee less shipping, with packing and blank warranty card, except film and paper. We ship UPS. Some items special order. All orders are subject to acceptance and verification. Products in this ad are supplied with Adorama's own exclusive warranty. Copies are available upon written request, may not include English instruction. Products are parallel imports which are not accompanied by manufacturer's warranty and not eligible for rebates offered by manufacturer unless mfg. or dist. warranty included. Second hand dealers license #802862. Pictures are for illustration purposes only and may not be exact.

Prices effective till September 3, '87

ALL FREE GOODS MUST BE REQUESTED AT TIME OF PURCHASE

ADORAMA

The Photography People

42 W. 18th St., New York, N.Y. 10011

TOLL FREE OUT OF STATE

800-223-2500

TELESCOPES ACCESSORIES

LUMICON

UHC FILTERS

1¼	79.50
48mm f/most 2" EP	159.50

DEEP SKY FILTERS

.96"	59.50	1¼"	79.50
2"	99.50	48mm	119.50

H-BETA

1¼	89.50	48mm	189.50

OXYGEN III

1¼	99.50	48mm	199.50

TELRAD

Finder w/Mounting Base	43.95

EASY GUIDERS

f/1¼ Newtonian Guider	169.50
f/2" Newtonian Guider	169.50
f/Cassegrain Guider	225.00
Giant Easy Guider f/C11, C14 or Meade 2120	395.00

SOLAR FILTERS

8" Solar Filter	149.00
1½" Solar Prominence Filter w/ Energy Rejection Pre-Filt	550.
3" Off-Axis Metal Mask	68.00

DIGITRAK
DRIVE CORRECTORS

Digital quartz controlled. No knobs to adjust, solar-lunar-sidereal tracking rates, portable power, rechargeable battery in VE400/400D runs C8 up to 10 hours, a must for astrophotography.

VE Digitrak

VE200 Single Axis	94.95
VE200D Dual Axis	153.95
VE300 Single axis, 12V DC input, remote control incl	132.95
VE300D Dual axis, 12V DC/120V AC input, remote ctl incl	182.95
VE400 Single axis, internal battery, remote control incl	173.95
VE400D dual axis, internal battery, remote control incl	212.954

FOCUS MOTORS

f/Celestron C-8, Powerstar	89.95
f/Meade 2080 LX3, 2120 LX3	98.95
f/Meade 2080 LX5, 2120 LX5	98.95
f/Meade & Celestron Refractors	84.95
f/Tele Vue Renaissance	89.95
f/Bausch & Lomb 4000, 8000	98.95

PUBLICATIONS

Edmund Mag 6 StarAtlas	16.95	Passport To The Stars	49.95
Celestron Sky Maps	15.95	Meade Star Charts	17.95
Celestron Product Guide/Ref. Manual	16.95		

TELESCOPES PARTS
PARABOLIC MIRRORS

IDAI 4.5" w/Matching Ellipical Flats	59.95
IDAI 5" w/Matching Elliptical Flats	79.95
IDAI 6" w/Matching Elliptical Flats	119.95

MEADE PARABOLIC MIRRORS

6" f/8	139.95	8" f/6	219.95	10" f4.5	409.95
6" f/5	149.95	10" f/6	409.95	12.5" f/6	639.95
16" f4.5	899.95				

MEADE ELLIPTICAL FLAT SECONDARY MIRRORS

1.3"	35.	1.83"	47.	2.6"	55.
1.52"	43.	2.14"	50.	3.1"	99.
4"	120.				

MEADE RACK & PINION FOCUSER

#67 1¼"	49.	#640 1¼"	89.	#680 1¼"	109.

DUST COVERS

7½" ID	14.95	9½" ID	19.95

BINOCULARS

MEADE
GIANT

11x80 Rubber Coated	224.95
20x80 Rubber Coated	244.95

NIKON

7x50 CF Star Vue	134.95
10x50 CF Sentinel	154.95
7x50 SPHP w/cs	439.95
10x70 HP w/case	354.95

SCOPES
W/CASE & 20X EYEPIECE

Spotting Scope	256.95
Spotting Scope ED	459.95
Photo Attachment	114.95
72mm Filter Ring	13.95
Hood	10.95
60X Eye Pc. Attch	49.95
15,30, 40xE.P.	Ea 46.95
Lens Scope Converter	49.95

STEINER

15x80 G Observer	513.95
15x80 C Obs w/Cmp	659.95
24x80 Telescope	399.95

ZEISS

Stereo Microscop Cvtr	129.95
15x60	Call

CELESTRON
GIANT

11x80	229.	20x80	247.
16x70	249.	30x80	269.

NEW Deluxe 14x80	499.95
20x80 Deluxe	419.95
NEW 25x125	Call
Car Window Mount	69.95

CLOSE OUT SPECIAL

7x35 Nova	84.95
8x30 Waterproof	179.95
10x40 Waterproof	219.95
10x50 Waterproof	279.95

SWIFT
MARK

Audubon 8.5x44	154.95
Osprey 7.5x42 (Armor)	124.95
Condor 10x42	129.95

GIANT

Observer 11x80 BCF	194.95
Satellite 20x80 BWCF	194.95
Spotting Scopes Telemaster 15-60x60	189.95
Searcher 20x40x60(12.6")	219.95

SWAROVSKI
CALL FOR PRICES

FUJINON ASTRONOMICAL BINOCULARS — INCLUDING THE WORLD'S LARGEST

NEW — "SX" Series for 95% light transmission
"F" Series flat field, ultra-low distortion

Fujinon "SX" binoculars are up to 25% brighter than any other high quality binoculars for outstanding night vision. And the new flat-field "F" series give the sharpest, most accurate, high resolution images of any binoculars available today. Technically, the binoculars have a plane of sharpness almost perfectly perpendicular to the optical axis. From the center to the edges, distortion and astigmatism are reduced to the point of invisibility. The "F" series also offer 23mm eye relief — the world's longest. "F" and "SX" binoculars rely on Fujinon's patented EBC coating on every optical surface. Housings are cast aluminum alloy, dry nitrogen filled, and 100% waterproof. All come with a lifetime limited warranty against any manufacturing or material defect. Suggested list prices: 7x50 FMT-SX — $499.95, 10x70 FMT-SX — $644.95, 14x70 MT-SX — $544.95; optional tripod adapter — $25. Fujinon also makes the 25x150 right-angle viewing binocular...the most powerful binocular in production — $8,950 (based on conventional viewing model used by the U.S. Navy and Coast Guard). Available now. If there's no Fujinon dealer near you, order directly — with 10-day free trial — from Fujinon. Major credit cards and certified checks accepted.

Shown: New 10x70 FMT-SX with optional tripod adapter

FUJINON INC.
10 High Point Drive
Wayne, New Jersey 07470
(201) 633-5600

FUJINON

LOS ANGELES OPTICAL COMPANY

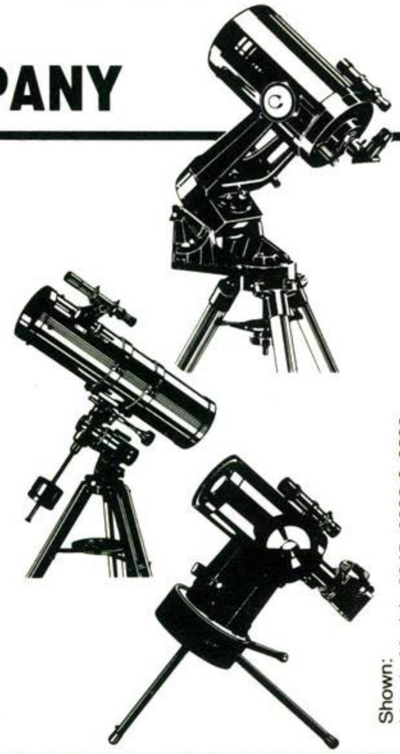
Los Angeles' only full-spectrum, stocking showroom telescope dealership featuring:

Authorized Meade Dealer

Meade®

Meade Instruments' full line of better-quality lenses, telescopes and accessories.

Stop by our large, well-stocked showroom for free demonstrations, assistance, information and literature regarding these and many other fine instruments, accessories, books, maps and charts.



Shown:
Meade Models 2045, 2080 & 6600

LOS ANGELES OPTICAL COMPANY

12129 Magnolia Boulevard (N.W. Corner at Laurel Cyn. Blvd.)
Los Angeles, (North Hollywood), California 91607
(818) 762-2206 Hrs: 10-6 Mon. thru Sat. MCRD/VISA/AMEX accepted

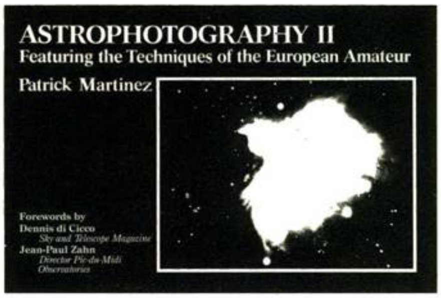
ASTRONOMY

Products for Observers

ASTROPHOTOGRAPHY II

by Patrick Martinez

NEW



ASTROPHOTOGRAPHY II
Featuring the Techniques of the European Amateur
Patrick Martinez
Forewords by
Dennis di Cicco
Sky and Telescope Magazine
Jean-Paul Zahn
Director Pic-du-Midi Observatories

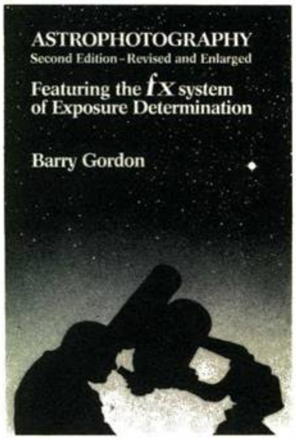
Martinez has written a complete intermediate to advanced level manual for the astrophotographer. Profusely illustrated with line drawings and photographs by European amateurs, **ASTROPHOTOGRAPHY II** covers the basics for beginners, as well as more technical topics such as films, developers, filters, masking and unsharp masking, reversal, composites, and much, much more! 107 photos (13 in color) illustrate solar, planetary, and deep-sky photography. Learn how to improve your techniques whether your subject is the Sun, Moon, planets, or beyond. Over 190 pages, paperback. **Please specify author when ordering.** #30150

ASTROPHOTOGRAPHY II by Martinez $19.95

ASTROPHOTOGRAPHY

by Barry Gordon

learn how to take beautiful astrophotos right from the start!



ASTROPHOTOGRAPHY
Second Edition - Revised and Enlarged
Featuring the *fx* system of Exposure Determination
Barry Gordon

- over 200 pages, 36 tables, 8 appendices
- 75 photographs taken with equipment available to amateurs

What can the "average guy" do in astrophotography these days? Well, **ASTROPHOTOGRAPHY** by Barry Gordon gives you the answer: PLENTY! Using only ordinary commercial lenses and telescope equipment, this book shows you how *you* can capture the spectacular beauty of the heavens on film. This is NOT a book full of observatory photos — these are pictures that you could have taken yourself. Order now — you will find **ASTROPHOTOGRAPHY** a valuable reference. **Please specify author when ordering.** #30125

ASTROPHOTOGRAPHY by Gordon $19.95

BURNHAM'S CELESTIAL HANDBOOK
An Observer's Guide to the Universe Beyond the Solar System
Robert Burnham, Jr.

BURNHAM'S CELESTIAL HANDBOOK: Burnham. The great modern classic about deep-sky objects; each constellation has an introductory section with descriptions of double and multiple stars, variable stars, star clusters, nebulae and galaxies. Includes photographs, tables, graphs and finder charts — a must for your library. 3 volumes, 2138 pages in all, paperback.

Vol. 1 — Andromeda through Cetus #30004
Vol. 2 — Chamaeleon through Orion #30005
Vol. 3 — Pavo through Vulpecula #30006

Vol. 1, $12.50; Vol. 2, $12.50; Vol. 3, $13.50

Philips' Planisphere

PHILIPS' PLANISPHERES

A **Philips' Planisphere** shows you the principal stars and constellations visible for every hour in the year. Just rotate the 2 plastic discs until the hour and the date coincide. Lightweight and made of waterproof plastic, a planisphere is portable and durable enough to be taken anywhere — backpacking, sailing or your own backyard.

The 10″ diameter size is available in 2 latitudes: 42°N and 32°N. PLEASE SPECIFY LATITUDE.

10″ PLANISPHERE 42°N (#30098) or 32°N (#30097) ... $9.50

PHILIPS' DELUXE PLANISPHERE. For the travelling observer — 3 planispheres in one! With interchangeable overlay discs for accuracy almost anywhere in the Northern Hemisphere. Includes 10″ snap-on overlays for 32°N, 42°N and 52°N and comes in an album-style pouch. #30102 **$14.95**

The nature of
LIGHT & COLOR
in the open air
M. Minnaert
mirages, haloes, shadows, double rainbows, hundreds of other phenomena visible with the naked eye ...explained by a famous physicist

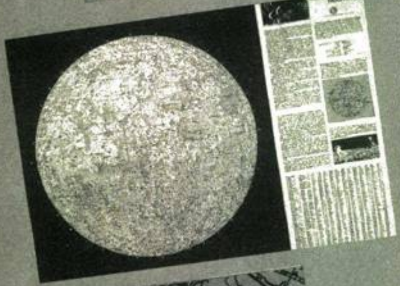
THE NATURE OF LIGHT AND COLOR IN THE OPEN AIR: Minnaert. A sky-watcher's classic for over 30 years! Tells all about "atmospheric optics" — rainbows, sundogs, mirages, multiple Moons, colored shadows, irridescent clouds, the green flash, and lots, lots more. Dozens of atmospheric phenomena — including some which are quite rare — are clearly and simply explained. 362 pages, paperback, #30069.

$7.50

A Starhopper's Guide To MESSIER OBJECTS
By Lenore

A STARHOPPER'S GUIDE TO MESSIER OBJECTS: Freeman. Shows you how to locate each of the 110 Messier objects by "hopping" to them from easy-to-find bright stars. Uses only the naked-eye stars of each constellation. 23 pages, paperback, #30042.

$7.50



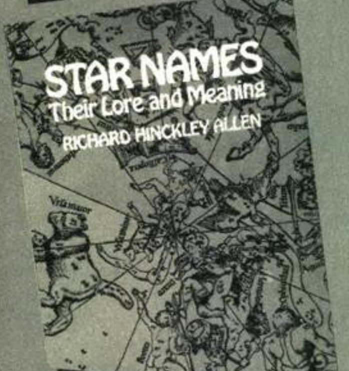
MOON MAP. Helps you identify the Moon's anonymous jumble of craters, hills and flat expanses you can see with your telescope. It includes an index, as well as a description of the Moon's original and surface features. Shipped folded in a protective cardboard cover, the **Moon Map** can be mounted for display. 20" x 29", #30068.

$4.95

CELESTIAL OBJECTS FOR COMMON TELESCOPES
BY THE REV. T. W. WEBB
VOLUME ONE: THE
VOLUME TWO: THE STARS

CELESTIAL OBJECTS FOR COMMON TELESCOPES: Webb. This classic covers the solar system (the Sun, Moon, planets, comets and meteors) as well as observing with a telescope in Volume 1, and deep-sky objects (grouped by constellation) in Volume 2. Valued as much for style as for content, this set is for every telescope owner. 606 pages in all, paperback, #30001.

$12.50 (set)


STAR NAMES
Their Lore and Meaning
RICHARD HINCKLEY ALLEN

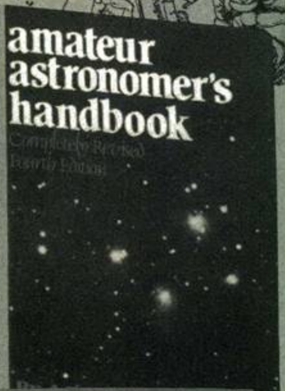
STAR NAMES: THEIR LORE AND MEANING: Allen. The classic source for the legends behind star names and constellations as well as other celestial folklore. 563 pages, paperback, #30003.

$8.50

The Best Deep-Sky Objects

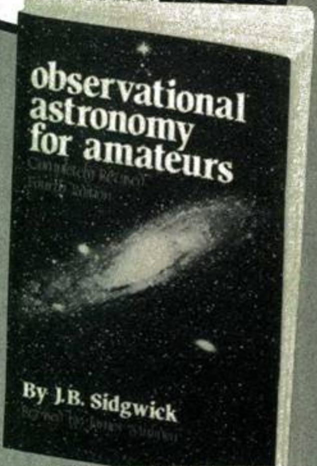
THE BEST DEEP-SKY OBJECTS. This handy card, printed on heavy stock and varnished for durability, shows where all the Messier objects are in the sky — plus the 51 best objects in the *New General Catalogue*. The front side displays them on an all-sky map (with an inset for the Coma-Virgo cluster of galaxies); the reverse tabulates each object and gives epoch 2000.0 positions, magnitudes, sizes, observing difficulty, type of object, constellations, and nicknames. 10" x 11-1/4", #18029.

$1.50 each or 50¢ each for 5 or more


amateur astronomer's handbook
Completely Revised Fourth Edition

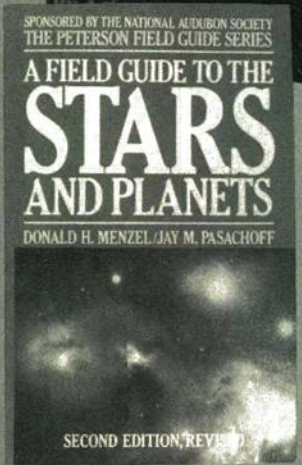
AMATEUR ASTRONOMER'S HANDBOOK, 4th ed.: Sidgwick. An indispensable reference which includes tips on telescope design and performance, eyepieces, mountings and drives, mirror and lens testing – as well as data on human vision, the Earth's atmosphere, time and coordinates. 568 pages, paperback, #30018.

$10.95


observational astronomy for amateurs
Completely Revised Fourth Edition
By J.B. Sidgwick

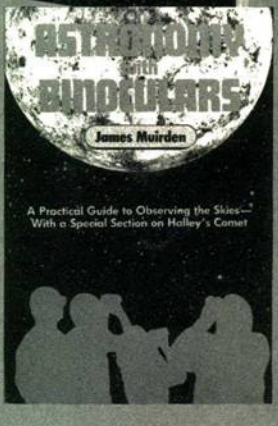
OBSERVATIONAL ASTRONOMY FOR AMATEURS, 4th ed.: Sidgwick. A collection of observing techniques covering the Sun, Moon and all the planets, as well as aurorae, meteors, zodiacal light and double stars. 348 pages, paperback, #30019.

$8.95


SPONSORED BY THE NATIONAL AUDUBON SOCIETY
THE PETERSON FIELD GUIDE SERIES
A FIELD GUIDE TO THE STARS AND PLANETS
DONALD H. MENZEL/JAY M. PASACHOFF
SECOND EDITION, REVISED

A FIELD GUIDE TO THE STARS AND PLANETS: Menzel and Pasachoff. This classic field guide (one of the famed Peterson series) has been thoroughly revised, expanded and updated to reflect the latest astronomical results and celestial mapping techniques. Includes a 52-plate star atlas, Moon maps, seasonal star charts and much more. Don't go skywatching without it! 473 pages, paperback, #30046.

$13.50


ASTRONOMY with BINOCULARS
James Muirden
A Practical Guide to Observing the Skies— With a Special Section on Halley's Comet

ASTRONOMY WITH BINOCULARS: Muirden. The classic guide to sky-watching with the simplest equipment. Includes how to buy a good pair of binoculars and observing projects. 156 pages, paperback, #30015.

$8.50

To order any item on these 2 pages, use the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., 1027 N. Seventh St., Milwaukee, WI 53233. Include for postage and handling: U.S. $1; foreign $1.50. Wisconsin residents add 5% sales tax.

The Moon on a Silver Plate

by Jan K. Herman and M. Susan Barger

The delicate images of the famous and the ordinary from the middle of the last century stare at us from the brightest of silver mirrors: daguerreotypes. How can we not be touched by daguerreotypes of Abraham Lincoln as a young Sangamon County lawyer; Daniel Webster as a dark-eyed political wizard; old, infirm Andrew Jackson several weeks before death; or Edgar Allan Poe's tormented countenance? But people weren't the only subjects for early daguerreotypists. In the 1840s and 1850s photographers and astronomers conspired to make the first astronomical images — daguerrean portraits of the Moon. Many were utter failures. But a few, particularly those made by Bostonians George Bond and John Whipple, remain some of the finest images of the cosmos almost 150 years later.

Early in 1984 our team, composed of an astronomer, a materials scientist, an historian, and a photographer decided to recreate the first photographs of the Moon, the photographs that foreshadowed the brief marriage of astronomy and daguerreotype photography. Using techniques a century-and-a-half old and a modern telescope at the U.S. Naval Observatory in Washington, D.C., we set out to produce high-quality lunar daguerreotypes as an experiment in historical photography. The daguerreotype was the first practical way to produce images with light and a camera. The "film" was a silver-coated metal plate polished to a mirror finish and exposed to iodine and bromine vapor to make it light-sensitive. This prepared plate was placed in a camera and exposed to light; suspending the plate over hot mercury vapor revealed the image. As in modern photography, the plate was fixed in "hypo," or sodium thiosulfate.

Even before Louis Jacques Mande Daguerre made the details of this revolutionary process public in August 1839, his champion, Francois Arago, director of the Paris Observatory, encouraged Daguerre to capture an image of the Moon. Although the artist obtained nothing more than the barest hint of a crescent, Arago saw great promise in this new technology. He used Daguerre's results to promote the application of daguerreotypy to scientific endeavors, claiming the process would have immeasurable benefit to science. He believed photography would give science the objectivity and measurable accuracy it had never had. It might also spawn new industries and could even have applications in the arts.

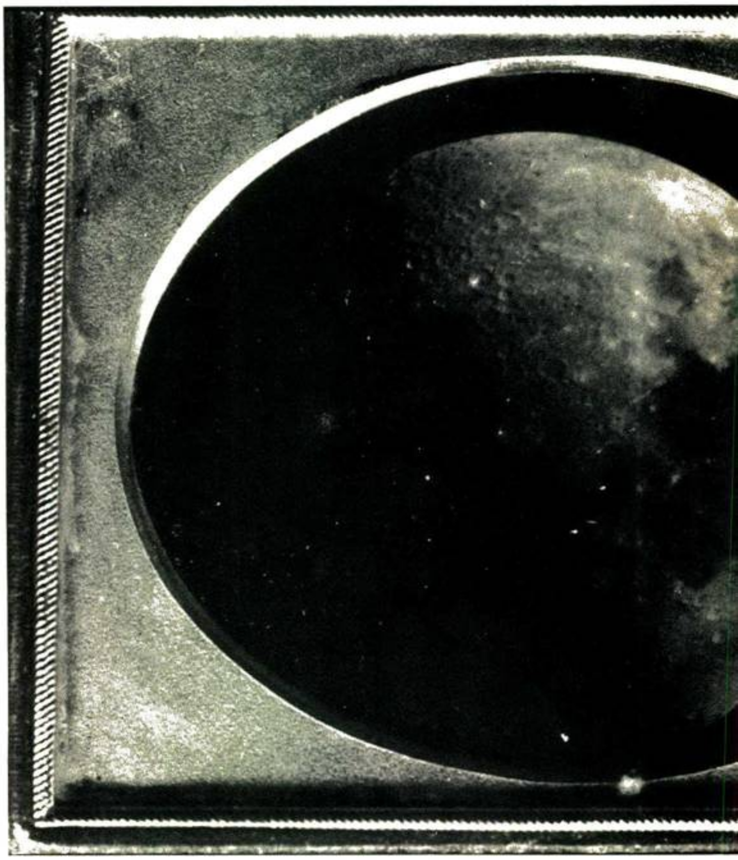
As early as 1840, physician John Draper, working in New York City, made successful daguerreotypes of the Moon. Shortly thereafter astronomers Hypolyte Fizeau and Leon Foucault in Paris, Vatican scientist Father Secchi, and William Bartlett and others in the United States experimented with the new medium.

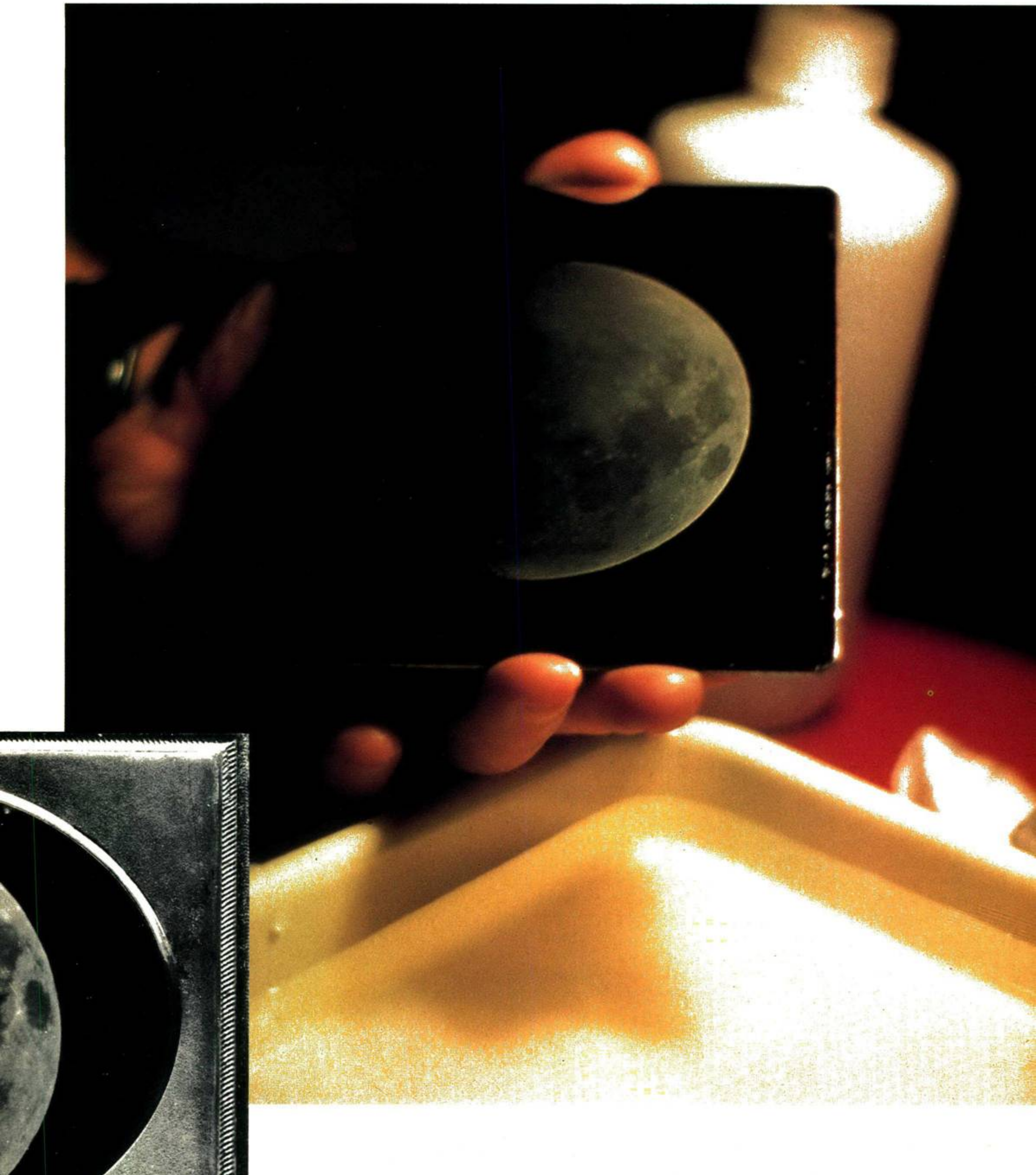
However, the partnership of astronomer George Bond and Boston photographer John Whipple raised the astronomical daguerreotype to its short-lived zenith. Using Harvard College Observatory's 15-inch "Great Refractor" as their camera, Bond and Whipple took a series of lunar daguerreotypes between 1849 and 1851. By trial and error they finally secured bright, sharp images of the Moon that won them honors at the 1851 Crystal Palace Exposition in London.

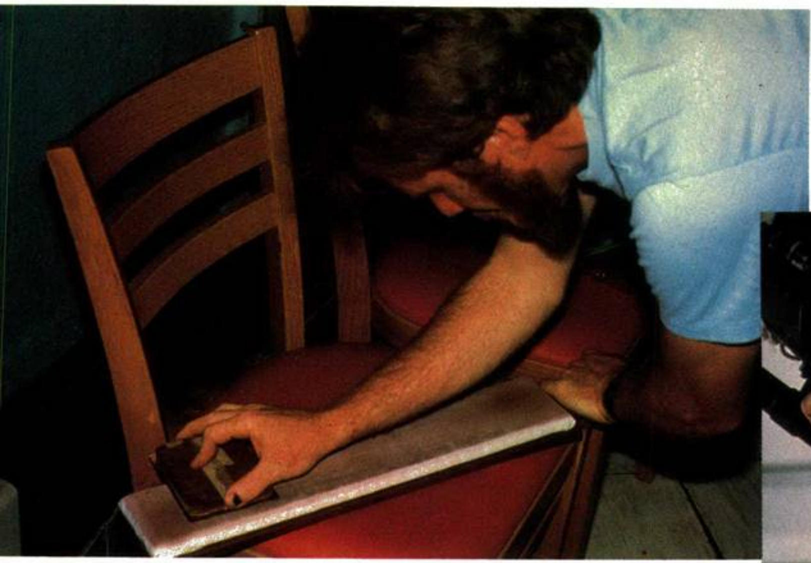
Our twentieth century daguerrean experiment began in 1984 when the authors became friends. Herman is historian of the old U.S. Naval Observatory in Washington, and Barger is an

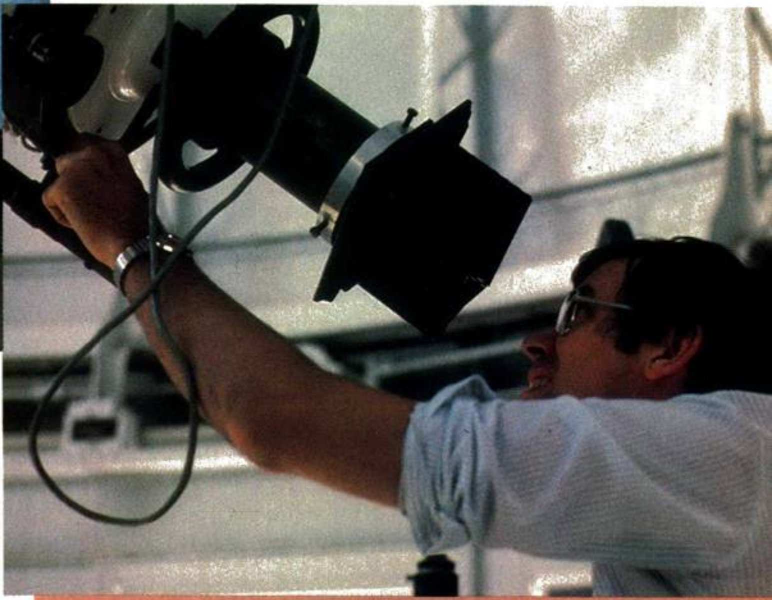
Right: A modern day daguerreotype image of the Moon, made 135 years later. This and the remaining photos in this article courtesy Jan Herman, U.S. Naval Observatory.

Below: Made in 1851 by Bostonians George Bond and John Whipple, this daguerreotype of the Moon won a prize at London's Crystal Palace Exposition. In time, however, the daguerreotype proved to be inadequate for astronomical photography. Courtesy Science Museum, London.









Left: Daguerreotypist Kenneth Nelson polishes a silver-coated copper plate to a mirror finish. This will be used as the daguerreotype plate.

Below: Astronomer Ted Rafferty focuses the Moon on the 12-inch refractor's ground glass screen at the Naval Observatory.

expert in daguerreotype photography at Johns Hopkins University. Because we work in related fields and have an interest in astronomy and photography, we decided to attempt taking our own daguerreotypes after we had seen the Bond-Whipple images. How could we accomplish such a feat?

Several months later we worked out a plan. The camera would be the Naval Observatory's antique 12-inch refracting telescope. Naval Observatory astronomer Theodore Rafferty would provide his expertise in operating the instrument. We, along with Rafferty and Kenneth Nelson, made our first attempt in July 1985 at the Moon's First Quarter in order to take advantage of long lunar shadows and sharp detail.

The 12-inch refractor already had a distinguished career dating back ninety-four years. Its long focal length and superior objective lens made it ideal for lunar and planetary observations. The telescope was constructed into a camera by modifying the eyepiece with a film back to hold a sensitized daguerreotype plate at the rear of the telescope.

The telescope dome became the darkroom and workshop needed to accommodate tools for polishing the plates and specially designed wooden boxes for exposing plates to iodine and bromine. The darkroom also held a ventilated hood containing the pot of highly toxic heated mercury necessary to create a visible image and trays of hypo and distilled water for rinsing.

Initially the most important task was determining the exposure time for the plates. This was no easy job because of the number of variables involved. Exposure time is dependent upon the characteristics of the daguerreotype plate itself, the way in which it is sensitized over the iodine and bromine vapors, and atmospheric conditions. (Unlike modern films, daguerreotype plates are not packaged with exposure information!) In trial-and-error fashion we sacrificed the first several plates while groping blindly for an image from which to determine an initial exposure time.

Because we didn't yet know what exposure times and guiding techniques would work best, that first evening was the most frustrating of all. After seven attempts in a dome packed with enthusiastic spectators the reward was only the faintest hint of the Moon. We were embarrassed and disappointed but not discouraged. At least we had a starting point for the next try.

The complexity of the operation required intense concentration. And each person had to perform his or her task in proper rhythm and sequence. During the first night we worked out our individual roles and learned what needed to be done to function as a team. Nelson polished and sensitized the plates. Rafferty pointed the telescope and focused the Moon's image. His major concern was ensuring that the telescope followed the Moon's movement precisely. Faulty tracking would result in a blurry image instead of a sharp picture much like the results you

The Daguerreotype Process

The all but forgotten art of making a daguerreotype is a complicated process that requires special skills and materials that are hard to come by. Virtually all the chemicals used to develop daguerreotypes are extremely toxic, and the precise mixture required to produce a satisfactory image makes success elusive. How are daguerreotypes made? Let's follow the process as a professional photographic studio would have during the late 1840s.

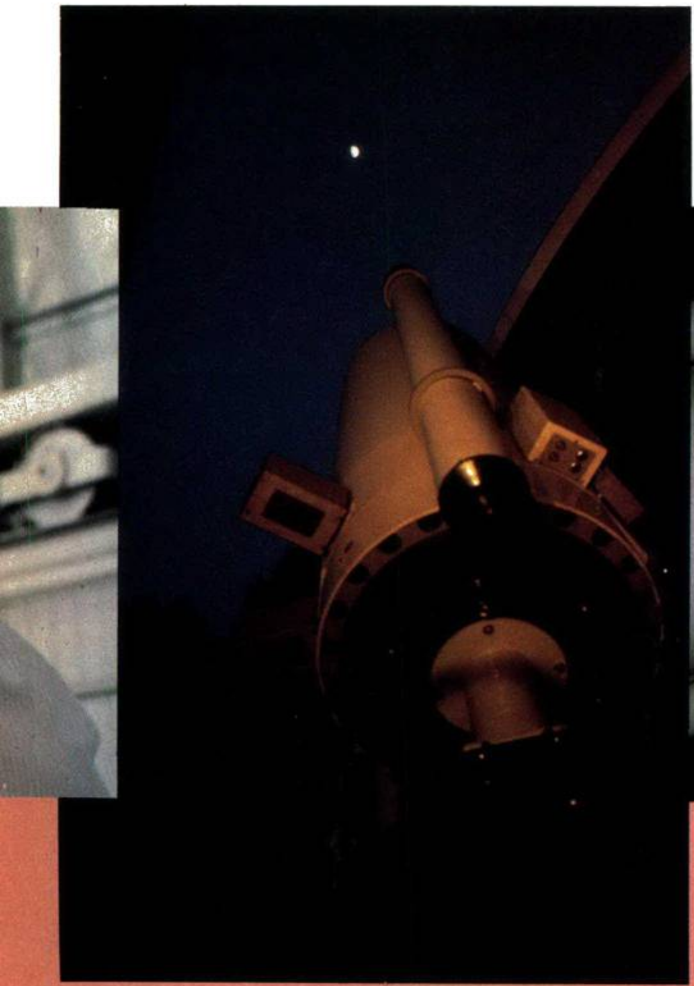
Daguerreotype plates must be custom-made by polishing a sheet of copper with jeweler's rouge until the sheet attains a mirror finish. The sheet copper used for plates must be absolutely flat and free of flaws, and the polisher must avoid scratching the metal surface. When the sheet has a satisfactory luster, it is plated with pure silver. The silver plating has to be done accurately, because any abnormalities in the plate texture or impurities in the coating cause image flaws on the final product.

Next the plate is exposed to iodine vapors in a sealed fuming box. The length of exposure time varies depending on chemical and temperature conditions, but the expert daguerreotypist knows this step is complete when the plate takes on a rich yellow color under subdued white light.

The plate is now exposed to bromine vapors in a second fuming box. Because of its potency, bromine must be used in diluted form and is usually suspended in calcium hydroxide powder. The fuming time varies depending on the concentration of the bromine in the box. When it is finished, the plate has a lavender color.

The daguerreotypist next illuminates the room with a dim red light and re-exposes the plate to iodine vapors for about half the original time.

After these three steps the sensitized plate is ready for



Left: The Navy's 24-inch reflector and a waiting target.

Below: Jan Herman ends a long exposure of the Moon by covering the telescope's front end with a board.

an exposure. Daguerreotype exposure times vary wildly, depending on the individual sensitivity of the plate, light conditions, temperature, and the camera and lens combination. The exposures generally range from a few seconds to many minutes.

Now comes the developing process. Under a dim red light the plate is placed back inside a fume-ventilating hood and suspended over a narrow-mouthed mercury vessel. An alcohol lamp or heating mantle brings the vessel to the proper temperature of between 75° and 80° C. An image should appear on the plate within two or three minutes. Having processed many plates, the daguerreotypist knows that if no image appears within that time, the exposure was likely unsuccessful.

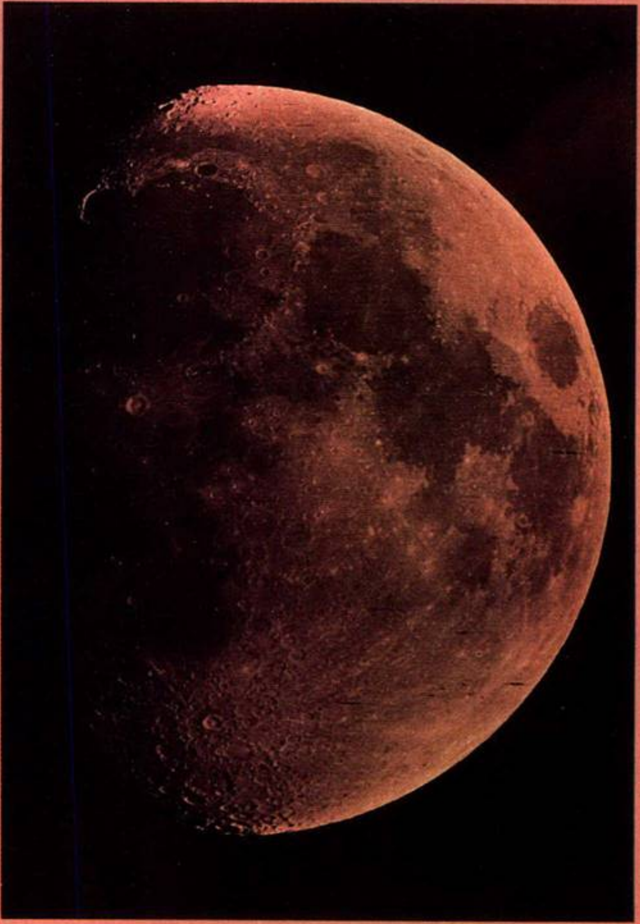
After the image is developed, the photographer places the plate in 5 percent sodium thiosulfate (hypo) solution and gently agitates the plate until all traces of yellowish, undeveloped silver salts disappear.

Now the plate is washed in distilled water with great care, because the image is extremely fragile and may smear if anything touches it.

The proficient daguerreotypist next bathes the plate in a solution of gold chloride, which brightens the image and makes it more durable. This final step is called "gilding."

After the plate dries, it is a finished daguerreotype and may be sold to the person who purchased it, added to the photographer's studio stock, or entered in a competition as an example of "one of the world's new marvels — photography!" *Jan K. Herman and M. Susan Barger.*

Below: Sunlight sparkles off the lunar limb in this modern day daguerreotype by the Naval Observatory team.



Left: Susan Barger develops an exposed daguerreotype plate over fuming mercury in a closed hood.

Below: The first glance at a modern daguerrean image of the Moon as it fixes in a hypo solution.

get by taking a photograph of a speeding car with too slow a shutter speed.

Once each plate was prepared, Nelson inserted it into the back of the telescope. We decided to regulate the length of each exposure by using the dome itself as a shutter. Opening and closing the dome thus marked the beginning and end of the picture, and it was Barger's job to time each exposure.

Success eluded us. Again that night enough silver was deposited on the plates to indicate that the exposure times were accurate, even though the images were indistinct blurs. We had neglected another important fact: white light is composed of all colors. In a refracting telescope the objective lens acts as a prism separating that white light into all its components. And each component — red, green, and blue — comes to a focus at a slightly different point. Daguerreotypes are only sensitive to the blue component; the other colors of light contribute nothing. In order to focus daguerreotypes correctly, we had to find where the blue light came to a focus and then make sure the plate was in that position during the exposure.

We also had a problem adjusting the telescope's tracking mechanism to follow the Moon's motion. Originally we didn't think this was serious because of the anticipated short exposure times. However, exposures turned out to be between three and six minutes, and tracking was very difficult.

These two problems were only partially solved. By the early morning hours we had exposed six plates, but none of them had the clarity and fine detail characteristic of daguerreotypes. Even so, we went home happy, feeling that we had come close to duplicating the pioneering work of George Bond and John Whipple.

Or so we thought. Later, after examining the records of Bond and Whipple, we found a common thread of frustration in our predecessors' experiments with Harvard's 15-inch refractor. On December 18, 1849, Bond wrote: "I renewed my experiments with high hope of success, but soon found it no easy matter to obtain a clear, well-defined, beautiful Daguerreotype of the Moon. Nothing could be more interesting than its appearance through that magnificent instrument: but to transfer it to the silver plate, to make something tangible of it, was quite a different thing." These nineteenth-century workers experienced the same problems with their refractor lens and telescope drive we had experienced. Bond's team had had several advantages. Because the team's experiments continued over several years, the team had been able to achieve good results by trial and error. The team found where to place the plate to get the best possible focus. Problems associated with the 15-inch refractor's clock drive were minimized, although they were never eliminated. The team members could purchase dependable daguerreotype plates whenever they needed them, something the modern team couldn't do. Whipple, as one of Boston's leading daguerreotypists, had ample opportunity to perfect his craft. We had the same stumbling blocks but far less time to get the process right.

Because of these challenges, the lunar daguerreotype experiment suddenly changed to a new tack. Instead of trying to duplicate the work of the nineteenth-century pioneers, we decided to test the limits of antique daguerrean technology. The new question was: Could an excellent daguerreotype be attained with the most modern telescope available? A year went by before we had the answer.

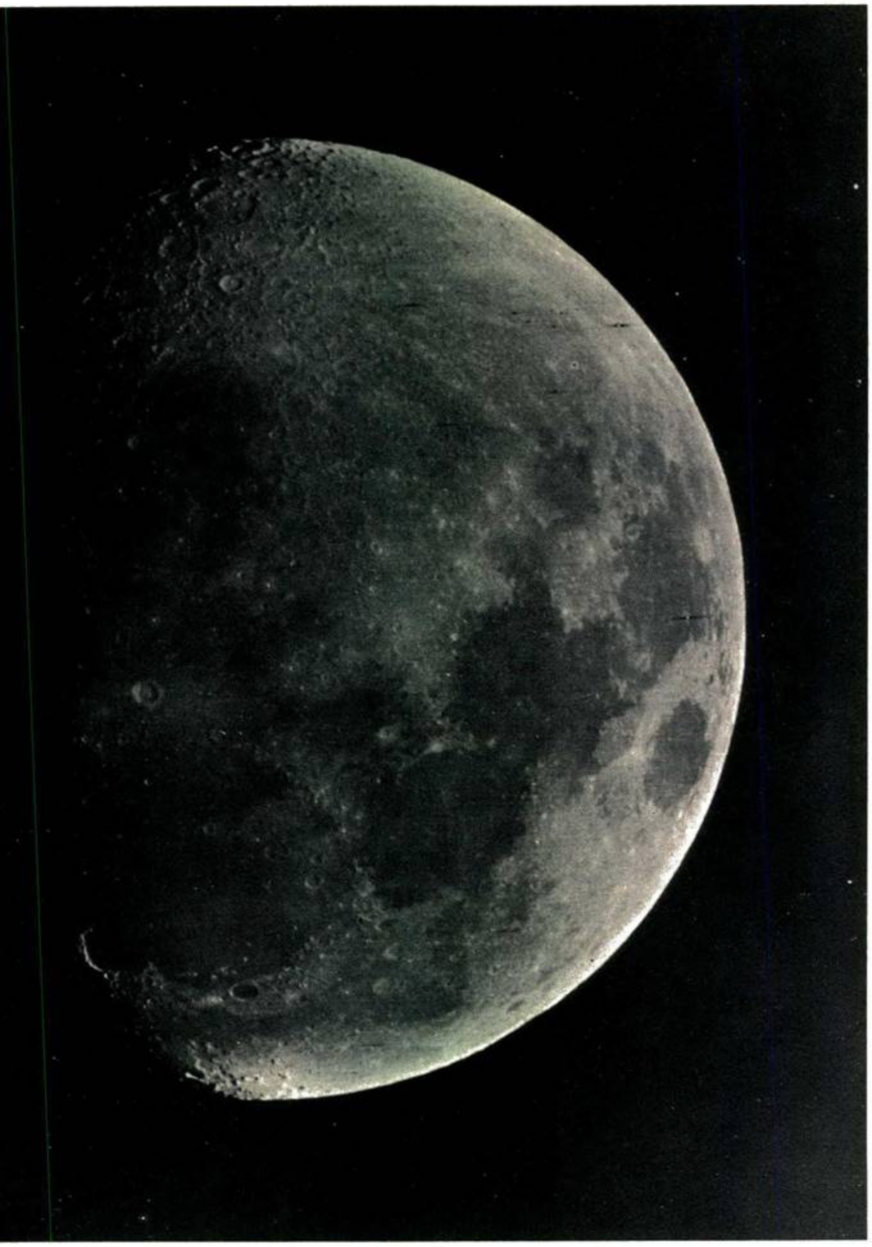
The new telescope, the U.S. Naval Observatory's 24-inch reflector, eliminated all the deficiencies associated with the 12-inch instrument. A reflector telescope uses a mirror rather than a lens to gather and focus light. There is no lens, so the prism effect is absent and all wavelengths of light come to a focus at the same plane. Thus, the problem of the exact location of the blue focus disappeared. This telescope gathered four times more light than the 12-inch refractor, bringing shorter exposures. The 24-inch also had a very sophisticated drive that could be adjusted to follow the Moon precisely. This eliminated the smearing effect produced by the Moon's motion. In addition, the new telescope had a guidescope with a narrow field of view and cross hairs of very fine tungsten wires that enabled our team to maintain a good fix on the Moon.

We worked two nights. The first evening was as hot and muggy as a Washington summer night can be. Although visible, the Moon didn't appear as bright as we had hoped because of atmospheric haze. As the Moon neared the western horizon, it reddened, which put it beyond the reach of the blue-sensitive daguerreotype plates.

We made several exposures, but only the last produced the desired results. The sharpness and clarity were astounding. We knew that if the next night was clear, the results would be dramatic.

The following day was clear and crisp, thanks to a passing cold front. At sundown we gathered in the dome and confidently posed for a formal portrait beside our telescope. Then we got down to work preparing and exposing plates with the 24-inch reflector. Our subject was already high overhead and a few days beyond First Quarter phase.

Following an 8-minute exposure and the requisite development over fuming mercury, we crouched expectantly over the



Left: History repeats itself in this modern daguerreotype of the lunar surface, which shows dark maria, brightly illuminated highlands and rays, and a peppering of finely detailed craters.

Below: Modern day daguerreotypists pose with the U.S. Navy's 24-inch scope. Left to right: Kenneth Nelson, Jan Herman, Susan Barger, assistant Lynne Gilliland, and Ted Rafferty.

fixing tray. As we watched the silver plate submerged in the hypo bath, a pock-marked disk slowly emerged from what looked like the blackest void of space. We greeted the exquisite image with triumphant shouts. The Moon's rugged features seemed to leap from the silvered surface. Mountain ranges and lunar valleys appeared astonishingly sharp and three-dimensional. Every tone from chalk white to coal black had been faithfully recorded. Central mountain peaks bathed in sunlight rose from the shadows of parent craters. Tycho and Copernicus displayed striking evidence of their cataclysmic births — diverging rays of debris splashed from the lunar surface billions of years ago.

The maria, or lunar seas, sparkled with a brilliant intensity. In fact, the overall image seemed to vibrate with a rich, luminous glow. There was no doubt that this silver plate could well hold the finest astronomical daguerreotype ever produced.

Before the session ended after midnight, six more plates were exposed and developed. But with the experiment a success, what had been gained? We had proved daguerreotypes could be taken with a nineteenth-century telescope only with the greatest difficulty.

So the exercise was a revelation. Only after struggling ourselves could we begin to comprehend the frustrations and accomplishments of the nineteenth-century pioneers. Bond and Whipple were extraordinary in their dedication to astronomy and to the craft of daguerreotype photography.

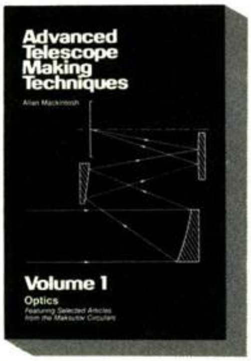
But dedication alone was not enough to ensure success in applying the daguerrean process to astronomy. Despite continued work, Bond was never able to record any celestial object dimmer than the star Vega. Moreover, reddish colored stars and planets eluded his silver plates entirely.

These important facts led us to the greatest discovery of all: Daguerreotypy was too insensitive for astronomy. Nevertheless, this process inspired the progress that followed. As Bond and Whipple had their initial successes, the daguerreotype was already bowing to the more versatile wet-plate process. By the late 1870s the more convenient and more sensitive dry plate became available and astrophotography at last became technically feasible. As scientifically useful as these photographic processes became, however, none could match the singular splendor of the Moon on a silver plate.

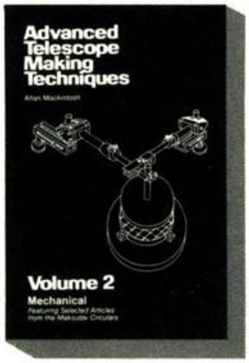
Jan K. Herman is historian of the old U.S. Naval Observatory in Washington, D.C., and the editor of Navy Medicine. *M. Susan Barger is a materials scientist at Johns Hopkins University in Baltimore and is well-known as an expert on daguerrean photography.*

Advanced Telescope Making Techniques

Volume 1: Optics



Volume 2: Mechanical



Grinding and polishing machines, spherometers, curve generation, making and testing optical flats, cement and tile tools — these are just a few of the many topics covered in two new volumes from Willmann-Bell. Featuring articles selected from the *Maksutov Club Circulars*, **Advanced Telescope Making Techniques** makes this treasure trove of information for advanced telescope makers available once more.

The *Maksutov Club Circulars* was published for nearly twenty years by the small group of sophisticated amateur telescope makers called the Maksutov Club. Under the editorship of Allan Mackintosh, over 200 issues were published — but copies soon became exceedingly hard to find. No one interested in telescope making can afford to be without these volumes. To obtain yours, order now.

Paperback, over 600 pages in all, 450 illustrations.

Vol. 1 $19.95 #30142

Vol. 2 $19.95 #30143

To order, use the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., 1027 N. Seventh St., Milwaukee, WI 53233. Include for postage and handling: U.S. $1; foreign $1.50. Wisconsin residents add 5% sales tax.

Your best buy in space – ASTRONOMY!

174,452* ready-to-buy readers will see the ads in this issue!

For information on advertising, call or write:

ASTRONOMY
Dana-Lynne Terry
Advertising Sales Manager
ASTRONOMY
1027 N. 7th Street
Milwaukee, WI 53233
Call toll-free: 800-558-1544

* Average paid circulation for the six months ended December 31, 1986, as filed with the Audit Bureau of Circulations, subject to audit.

FOR INFO CALL (201) 444-7367

CAMERA DISCOUNT CENTER

NEW JERSEY TELESCOPE HEADQUARTERS

770 ROUTE 17 NORTH
PARAMUS, NJ 07652

Open Mon.-Sat.
10:30 AM-8:00 PM

NEW
Meade 2080LX/5 $1799
Accessories Include:
- Deluxe 1¼/2" Star Diagonal
- 9x60 Quick-Release Finder
- Self-Contained Batteries
- Hand Control w/Focus Button
- New MCOG Coatings

NEW
Meade MTS Telescopes
CALL FOR LOW PRICES

Meade 2120 Gem ... $1799

Meade 2080 Gem $749

Meade 2045 $549
2045LX3 .... $699

Meade 97D $309
97E $359

Meade 107D CALL FOR LOW PRICE

Meade PATH FINDER 15-60X Spotting Scope $249

Meade GIANT BINOCULARS

11X80	$229
11X80 Rubber	$239
20X80	$249
20X80 Rubber	$267
30X80	$259

Meade SUPER PLOSSL'S 52-DEGREE FIELD

6.4mm	$74
9.7mm	$74
12.4mm	$74
15mm	$74
20mm	$74
26mm	$74
32mm	$94
40mm	$94
56mm (2")	$165
2X Barlow	$73
2.8X Barlow	$73

Meade SUPER WIDE ANGLE 67-DEGREE FIELD

13.8mm	$115
18mm	$125
24.5mm	$136
32mm (2")	$190
40mm (2")	$249

Meade ULTRA WIDE ANGLE 84-DEGREE FIELD

4.7mm	$134
6.7mm	$165
8.8mm	$195
14mm	$220

CELESTRON Super C-8 Plus w/Starbright w/Wedge & Tripod CALL

CELESTRON Super Polaris C-8 w/Starbright $1069

CELESTRON C-90 Astro Scope CALL
Sky Sensor $249

NEW
CELESTRON Power Star 8 w/Starbright w/Wedge and Tripod $1649 complete

CELESTRON Giant Binoculars

11X80	$217
20X80	$233
30X80	$245
16X70	$269
20X80 Deluxe	CALL

Tele Vue Eyepieces
FULL LINE IN STOCK
WE WILL BEAT ANY LEGITIMATE PRICE!

SPECIAL
BAUSCH & LOMB Criterion 8000
Accessories Include:
- Field Tripod & Wedge
- 18mm Eyepiece
- 30mm Eyepiece
- Star Diagonal
- 8x50 Finder Scope
- Carrying Case

List $2293.95 .... $849.00

NEW
BAUSCH & LOMB Criterion 8001
Accessories Include:
- Field Tripod & Wedge
- 18mm Eyepiece
- 30mm Eyepiece
- Eyepiece Adaptor
- Star Diagnoal
- 8x50 Finder Scope
- Instruction Manual
- Self Instruction Guide
- Carrying Case

Also included are Enhanced Optical Coatings (enhanced aluminum primary mirror, silvered secondary mirror, MgF_2 coated corrector plate), giving 20% greater light transmission. Coatings are backed by the Bausch & Lomb lifetime warranty.

List $2600 $1299

BAUSCH & LOMB 4000 Professional Telescope
20% Greater Light Transmission
Accessories Include:
- 18mm Eyepiece
- 30mm Eyepiece
- Latitude Adjuster Legs
- Carrying Case
- 4X Finder Scope
- Star Diagonal
- 2X Barlow
- Camera Adaptor

List $1070.00 $509.95

BAUSCH & LOMB Criterion 4000 Observatory Telescope
Accessories Include:
- 18mm Eyepiece
- 30mm Eyepiece
- Latitude Adjuster Legs
- Carrying Case
- 4X Finder Scope
- Star Diagonal

List $950.00 $449.00

MINOLTA Binoculars

COMPACT	
7x21	$59
8x24	$69
10x25	$89
STANDARD	
7x35EW	$69
8x40EW	$74
10x50EW	$89
ZOOM	
7x15x35	$119
7x21x50	$139

BAUSCH & LOMB DISCOVERER 15-60X Zoom Spotting Scope $199

SPECIAL
Jason 323 480mm Telescope $99

FOR PHONE ORDERS ONLY — CALL TOLL FREE

☎ **1-800-631-7111**

New Jersey Residents & Information
(201) 444-7367
WE ACCEPT ALL MAJOR CREDIT CARDS
On all phone orders call
Mon.-Sat 10:30 AM-8:00 PM

All merchandise shipped w/USA warranty & complete manufacturer's packaging. Minimum shipping and handling $4.95. Not responsible for typographical errors. Refunds within 7 days of receipt. Shipping & handling non-refundable. Some items subject to mfg. increase/decrease. Pictures for illustration purposes only.

ACCESSORIES IN STOCK

PRICE BUSTERS

CALL NOW! 203-658-0701

SCANNER!

LX5
2080

ASTRONOMICAL OBSERVING AND PHOTOS MADE EASY!

- ELECTRONIC COMMAND!
- 9 x 60 V.F.
- 2" GIANT DIAGONAL
- SCANNER 8x SPEED!

INCREDIBLE LOW PRICE!

NEW ENGLAND ASTRO-OPTICS, INC.
BOX 834, Simsbury, CT 06070
— CATALOG PACKAGE — SEND $2.00

J-ASTRO
20 Argonne Plaza, Box 321
Oak Ridge, TN 37830

ASTROPHOTOGRAPHY HELP FOR BEGINNERS. Easy to use tables to find exposure times for your camera/telescope for *ANY* film speed for many planetary/deep sky objects $15. IBM PC/compatible software programs available $30.

Write or call 615-693-9425. Business Hours 7-9pm EST. (Answer machine other times).

ASTRO KITS

AT LAST! A precision sidereal rate DC camera drive for easy astrophotography.

- 35 mm camera drive kit
- Fast polar alignment
- Custom designed brass gears
- Small—Fits in your camera bag
- Weighs only 2½ Lbs.
- Operates on 4AA cells or 12v cigarette lighter plug
- DC-DC converter extends batteries and regulates power
- Curved rod—no tangent error
- Weight compensation control
- Easy assembly—no woodworking

★ *Coming Soon - Quartz controlled stepper motor version* ★

Send check for $99.00 plus $3.50 UPS—No bank delay

★★ **SPECIAL — Add $25.00 for fully assembled drive** ★★

ASTRO KITS
824 Bronx River Road
Bronxville, NY 10708

Call: 914-776-1931
for details

ANNOUNCEMENT — The Astronomical Society of East Texas meets monthly on the first Tuesday at 7:30 p.m. at Tyler Junior College, Tyler, Texas. Contact Kevin Hill, 828 Vine Heights, Tyler, TX 75701.

ANNOUNCEMENT — Alumni of the Rogers High School astronomy program have raised money for the restoration of a group of 128 16" Cassegrain. Need a copy of operators manual and manufacturer's list. Contact Richard Shea, P.O. Box 2785, Whitehouse, OH 43571.

ANNOUNCEMENT — Telescope Users Clinic. Basic clinic on what to buy, how to use it. October 17, 1987. 10 a.m. to 5 p.m. Sponsored by Western Observatorium, Inc., at Whittier College, Whittier, CA. Contact Pat Heath, 13215 East Penn Street, Suite 411, Whittier, CA. Phone (213) 696-0619.

ANNOUNCEMENT — $200 reward for information leading to recovery of 18-3/4" f/5.6 ultra-thin (one inch) mirror stolen on June 23 from my house. Contact Rick Decker, 1123 Western Avenue, Mill Valley, CA 94941. Phone (415) 956-7070.

ANNOUNCEMENT — Greater Temple Computerized Astronomical and Margarita Society (GTCAMS) holds monthly meetings on weekends nearest to New Moon. Central Texas. Contact the club at P.O. Box 365, Troy, TX 76579.

ANNOUNCEMENT — The Bucks-Mont Astronomical Association meets monthly on the first Wednesday at 8 p.m. in the farmhouse at Tamanend Park, Southampton, Pennsylvania. Starwatch following the meeting, weather permitting. Contact Brad Miller, 1335 Commonwealth Drive, Newtown, PA 18940.

FOR SALE: Part of heat shield of space vehicle, 1" x 1" x 1" square, (blackened by heat upon reentry into earth's atmosphere) mounted on solid white oak 4 ½" x 3 ¾", approx. ¾" thick, with blue felt on the back side. Brass plaque 3" x 1" with black engraving: "Heat Shield from Aurora Seven, Mercury - Atlas 7 — M. Scott Carpenter, May 24, 1962." Price: $2000 (or highest offer).

Contact: **Stefan Böhle, General Manager, ALB Danziger Strasse 4, D - 7928 Giengen, F.R.G.**

20mm Erfles

Research
Grade

Meade closed these out so we bought lots!
- 65° apparent field, 1-1/4"
- Very Low Price

VISA • MC • CHECK

$49⁵⁰

astro•tech
101 WEST MAIN ■ P.O. BOX 2001
ARDMORE, OKLAHOMA 73402
405/226-3074

30 Day Money-Back Guarantee!

WE QUOTE THE LOWEST PRICES!
ON MEADE TELESCOPES AND ACCESSORIES! CALL (714) 530-3861

SERIES 4000
BEST BARGAIN

SUPER PLOSSL
6.4, 9.7, 12.4, 15,
20, 26mm 69
32, 40mm 89
56mm 159

SUPER WIDE ANGLE
13.8mm 109
18mm 119
24.5mm 129
32mm 189
40mm 249

ULTRA WIDE ANGLE
4.7mm 129
6.7mm 159
8.8mm 189
14mm 219
Barlow 2X, 2.8X..... 69

NEW!! NEW!! NEW!!

2080 LX5	Complete pkg.	**1695**
MTS-SC8	8" F/10 Schmidt-Cassegrain ..	**.849**
MTS-SC10	10" F/10 Schmidt-Cassegrain .	**1399**
MTS-SN6	6" F/5 Schmidt-Newtonian ...	**.599**
MTS-SN8	8" F/4 Schmidt-Newtonian ...	**.849**

(Call for Details)

CENTURY TELESCOPE 12555 Harbor Bl.. Garden Grove, CA 92640

ASTRONOMY Advertisers
October 1987

Achterberg, Evert	108
ALB — Geschaftsstelle	105
Ad-Libs Astronomics	34
Adorama Camera	94-95,107
Advance Camera	92
ATI	39
Astro-Audio	92
Astro Cards	106
Astro Kits	105
Astro-Tech	105,107,108
Astronomy Book Club	27
California Telescope Co.	44-45
Cambridge University Press	25
Camera Discount Center	104
Celestial Innovations	109
Celestron International	120
Century Telescope Center	105
C.O.M.B. Direct Marketing	89
Cosmic Connections, Inc.	106
Coulter Optical Co.	90
Creve Coeur Camera & Video	41
Edelman's	73
Edmund Scientific	91
Focus Camera, Inc.	88
Fujinon, Inc.	95
Galactitag	106
Halcyon Films & Video	109
Harvard University Press	41
Hayes & Nolly Productions	107
The International Space Center	108
J-ASTRO	105
Jim's Mobile Industries	107-108
Los Angeles Optical Co.	95
Lumicon	64-65
MacMillan Publishing Co.	41
Meade Instruments	2-3
Meteorites	106
National Camera Exch.	30,118
New England Astro-Optics	105
Northern Sky Telescopes	85
Optica b/c Co.	109
Orion Telescope Center	56-57
Parks Optical	36-37
Pauli's Optics	106,107,108
Quasar Optics	107
Ricon Enterprises	109
The St. James House Co.	109
Science & Art Products	107
Scope City	43
Scope City (Canada)	108
Sky Instruments	109
TBR Optical	107
TeleVue	23
Tuthill, Roger W., Inc.	55
Unitron	87
Vista Instrument Co.	106
Vogel Enterprises,Inc.	106,109
Zephyr Services	109

AstroMart notices are free to all our readers for non-commercial purposes — but only two per person, per year, please. Limit your ad to 40 words including your name and address and allow 4 to 6 months for it to appear. All notices are subject to review for suitability. AstroMedia assumes no responsibility for statements made in notices or for the quality of advertised items. Send notices to: Astronomy Magazine, Editorial Dept. AM, 1027 N. Seventh St., Milwaukee, WI 53233.

Astro Photographer's Dream

New Vista Camera Tracker

- Precision tracking
- 96 tooth bronze worm
- 117 V. syncro motor
- Equatorial mount
- Sturdy construction
- Weighs only 4 lbs.
- Mounts on tripod
- Polar axis boresight
- Optional borescope
- Optional weights
- Opt. DC-AC converter

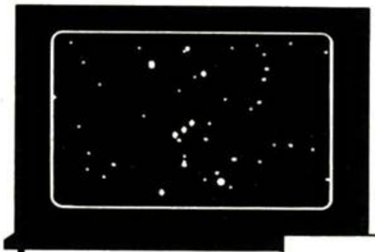
$195 PLUS $5 SHIPPING

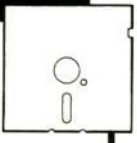
CA add 6% sales tax

Send for free literature or call

(805) 922-2545

VISTA INSTRUMENT CO.
P.O. Box 1919-B
Santa Maria, CA 93456





Plot Star Maps on Your IBM-PC!

STARS.BAS
STARS.DAT

As a service to its readers, ASTRONOMY is pleased to offer diskettes, for the IBM-PC and its compatibles, containing the STARS.BAS program and the STARS.DAT data file of 1573 stars. This software was described in "How to Plot Star Maps On Your Computer," ASTRONOMY, August 1985. A free copy of this issue will be included with each diskette.

Terms: The cost of the diskette is $29.95. The program is not copy protected, but is copyrighted software. Neither the program nor the data file may be used for commercial purposes, nor may it be re-sold. While we cannot guarantee that the program will work with your computer's BASIC, if the diskette is defective, we will replace it when you return the original defective diskette to us.

#18027

To order, use the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., 1027 N. Seventh St., Milwaukee, WI 53233.

Include for postage and handling: U.S. $1; foreign $1.50. Wisconsin residents add 5% sales tax.

STARS.BAS/ STARS.DAT diskette

$29.95

FOR SALE — Astronomy books. Space, science, and other items. Please send large, SASE for six-page list of hundreds of good values. Contact Edward Oravec, 104 Bella Vista, Tuckahoe, NY 10707.

FOR TRADE — Large collection of NASA videos covering manned and unmanned flights. Most recorded directly from NASA television. Contact Terry Fortner, 104 West Garner, Goodman, MO 64843. Phone (417) 364-7206.

Telescopes • Binoculars • Astro-Aids
Bausch & Lomb Professional Series

We will not be undersold!

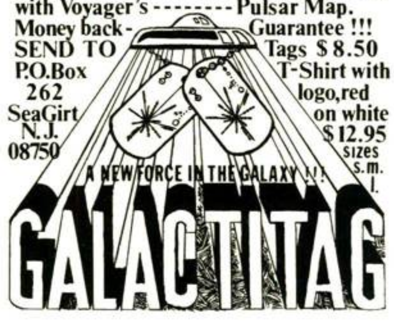
— Catalogs $3.00 —

PAULI'S WHOLESALE / DISCOUNT OPTICS
29 Kingswood Rd., Danbury, CT. 06811,
Tel. 203-746-3579

IF you are abducted by alien beings, lost in space, and escaped---- how could you find your way back to earth???

»»»GALACTITAG«««

Fashionable military dog tags imprinted with Voyager's --------- Pulsar Map.



A NEW FORCE IN THE GALAXY !!!
GALACTITAG

Money back- Guarantee !!!

SEND TO
P.O.Box
262
SeaGirt
N.J.
08750

Tags $ 8.50

T-Shirt with logo,red on white $12.95

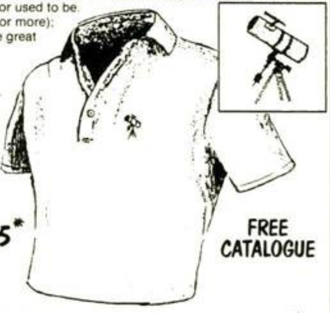
sizes s.m. l.

The Telescope Shirt

What the fashionable astronomer is wearing! Great conversation starters. A sport shirt with a little telescope embroidered where the alligator used to be.

Buy one (or more): they make great gifts!

Available in red, white, lt. blue, tan & navy S.M.L.XL



$16⁹⁵*

FREE CATALOGUE

To order, send check, money order, M/C or Visa number. *Include $2 postage & handling. Specify size and color. IL residents add 7% sales tax. Allow 4-6 weeks for delivery. In IL call 1-312-456-8725.

Vogel Enterprises, Inc., P.O. Box 3717, Oak Park, IL 60303

Or Call 1-800-457-8725 TOLL FREE

TeleVue Optics from Cosmic Connections

Plossls 50° Field (except 40mm)

Focal Length	O.D.	Price
55mm	2.00"	$203
40, 32mm	1.25"	102 each
26, 21, 17, 13		
10.5, 7.4, 1.8x, 2.5x	1.25"	86 each

Naglers 82° Field of View			Wide Fields 65° Field of View		
13mm	2/1.25"	$278	40mm	2.00"	$325
11mm	2/1.25"	263	32mm	2.00"	255
9mm	2/1.25"	243	24mm	1.25"	180
7mm	1.25"	203	19mm	1.25"	165
4.8mm	1.25"	165	15mm	1.25"	150

NEW!! 12mm, 16mm, & 20mm Nagler - CALL
TERMS: Check, money order, Visa, MC, Amex
Signature required for credit cards
IL residents add sales tax
Add $3.00 for postage -- Foreign orders add $15.

Cosmic Connections, Inc.
1460 N. Farnsworth Avenue
Aurora, Illinois 60505
312-851-5353
VISA MC American Express

Prices subject to change due to fluctuating dollar value overseas.

FOR SALE — Unitron 3" equatorial refractor model 142C, complete including drive, Unihex, six eyepieces, solar projection screen, and storage boxes. Excellent condition. $850, FOB. Contact Bill Moore, 4216 Bowser Avenue, Dallas, TX 75219. Phone (214) 522-4135.

FOR SALE OR TRADE — 64Kb TRS-80 Color Computer I with disk drives, modem, OS-9 and FLEX operating systems, joysticks, and more. $595 or trade for large aperture Dobsonian. Contact Kip Ingram, 12707 Pond Woods Road #1631, Austin, TX 78729. Phone (512) 335-9816.

FOR SALE — Meade DS-16 telescope minus mount. Nearly new condition. Will deliver four hundred miles. $875. Contact John Thompson, Box 61, Burt, IA 50522. Phone (515) 924-3774.

FOR SALE — 4" Schmidt camera with three filter holders. $700. Celestron Super C-8 with special coatings, tripod and wedge, porro-prism, four eyepieces, camera adaptor, counterweights, telextender, filters. $1,000. Dual-axis drive corrector, new. $300. All in excellent condition for $1,700. Contact Arlene Dziedzic, 379 Bayview Drive, Lusby, MD 20657. Phone (301) 326-2691 after 7 p.m.

FOR SALE — 510 back issues of ASTRONOMY, through 1974. *Sky & Telescope*, through 1953. $200, plus shipping UPS. 11x80 University. $125. 8x30 Zeiss, 7x50 WW II binoculars, stereo eyepiece attachment. Need giant binoculars, 5" f/5 objective and 8x50 periscope. Contact John Porter, Route 1, Box 49, Cotter, AR. Phone (501) 435-6415.

METEORITES

AVAILABLE TO
ASTRONOMERS, SCHOOLS
INSTITUTIONS AND PRIVATE
COLLECTORS. STONES & IRON
SPECIMENS. **LIMITED SUPPLY.**

ROBERT A. HAAG — METEORITES
Box 27527. Tucson. AZ 85726

— PLEASE SEND $1.00 FOR FULL COLOR CATALOG —
Refundable on first order

INDEX CARD FINDER CHARTS

75 - 3×5 charts per set. For use at the telescope!

AC-1 **MESSIER OBJECTS:** AC-2 **FINEST NGC OBJECTS**
AC-3 **DOUBLE STARS:** AC-4 **FINEST NGC, part B**
AC-5 **NGC FOR LARGER TELESCOPES (Min. 8 - inch)**
$7.50, 2 or more sets $7 ea. 4 or more $6.50 ea.

OBSERVER'S GUIDE A bi-monthly telescope guide. With finder charts, photos & visual descriptions. USA $12, 2 yr- $21, Canada $18, OTHER COUNTRIES $18.
OBSERVER'S LOGBOOK with 100 forms $18.95

VIDEO TAPES (VHS or BETA) *(VHS/PAL) $29.95 ea. *AMERICA IN SPACE, *APOLLO 11, *JUPITER/SATURN, *MARS, URANUS, *UNIVERSE, *SHUTTLE 1 to 8, *SATELLITE RESCUE, COMET HALLEY, STS-1.

TAPE PROGRAMS with 40 slides — $14.95 ea. APOLLO 11, APOLLO 17, COMET HALLEY, JUPITER, MARS - Viking, SATURN - Voy. 1, SATURN - Voy 2, STS - 1, STS - 2, UNIVERSE, MT. ST. HELENS, DIXON SPACE ART, BONESTELL'S SPACE ART, GENESIS.

SPACE SPECIAL Galaxies, Solar System 100 slides $32.95

20 SLIDE SETS. Mercury, Venus, Mars, Jupiter - Voyager 1, Jup. Voy. 2, Saturn - Voyager 1,Sat. - Voy. 2, STS - 1, BEST STS. APOLLO11, COMET HALLEY, Uranus, Universe. $9.50 ea. set

Send 39¢ stamp for FREE slide catalog. Outside USA add 20% extra.

ASTRO CARDS Phone 412-295-4128
P.O. Box 35, Natrona Heights, PA 15065

Meade

THE LEADER'S EDGE

IN STOCK
7x50 Binoculars
97E
2045/LX3
320
2080/LX5
8800

CHICAGOLAND'S ASTRONOMICAL HEADQUARTERS

Cosmic Connections, Inc.
1460 N. Farnsworth Avenue
Aurora, Illinois 60505
312 851 5353
VISA MC American Express

Catalog $2.00

FOR SALE — Bausch & Lomb Criterion 4000 4″ SCT with standard accessories. $385. Bausch & Lomb 2x Barlow. $20. Celestron 5mm and 12mm orthoscopic eyepieces. $35 each. Bausch & Lomb RFT adaptor. $55. Meade nebular filter. $45 (all 1-1/4″). Heavy-duty tripod for most 4″ SC telescopes. $80. All used less than one year. Excellent condition. Prices include shipping. Contact Martin Kaufmann, 2570 Miami Trail, Springfield, IL 62702. Phone (217) 525-2775.

FOR SALE — ASTRONOMY back issues. Complete set. Good to excellent condition. $400 or best offer. Contact John Hanson, 5721 Heritage Hill Court, Alexandria, VA 22310. Phone (703) 960-5721.

FOR SALE — 10″ f/5.6 Newtonian. Homebuilt with Coulter optics. 5mm, 10.2mm, and 20mm eyepieces. 8x50 finder. $300 plus shipping. Contact Gary Schirtzinger, 1893 Circle Drive, Juno, FL 33408.

FOR SALE — Two counterweight sets and Meade 622 aluminum piggyback plate assembly (no rings) for Meade 2120 attachment. Homemade and very sturdy. All for $125. Send SASE for picture and further description. Contact James Martinez, 823 Old Settlers Trail #2, Hopkins, MN 55343. Phone (612) 936-9453.

FOR SALE — Edmund 6″ f/8 reflector. Equatorial mount, 1-1/4″ focuser, 15mm RKE, and 47mm eyepieces, Barlow (2x-3x), and Meade 6x30 finder. Photos upon request. $400. Contact D. Smith Mullin, 1628 West James Street, Norristown, PA 19403.

Telescopes • Binoculars
Photo-Accessories • Microscopes
Dealer Inquiries Invited
IMPORT EXPORT
WE HAVE IT ALL!
14 x 100, 25 x 100
Binoculars — $795.
11 x 80, 20 x 80 — $195.
Catalogs $3.00 — (203)-746-3579
PAULI'S WHOLESALE / DISCOUNT OPTICS
29 Kingswood Rd., Danbury, CT 06811

CANADA
Meade®
THE LEADER'S EDGE
Catalog $4.00
Western Canada's Largest Scope Dealer
Binoculars, Maps, Books,
Films and Telescopes
Full, store-front location
master charge VISA®
QUASAR OPTICS
7220A FAIRMOUNT DR. S.E.
CALGARY, ALBERTA T2H OX7
(403) - 255 - 7633

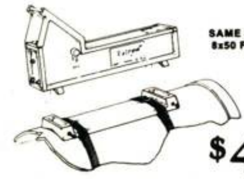
FOR SALE — 6″ Criterion reflector. Clock drive; 6x30 finder scope; 4mm, 6mm, 9mm, and 18mm eyepieces; and Meade camera adaptor. $295. Phone Matthew Heller at (203) 323-5936.

FOR SALE — Edmund 8″ f/5 Newtonian reflector. 28mm eyepiece. Fork mount with clock drive. Great shape. $490. C90 spotting scope. Diagonal and two eyepieces. $350 or reasonable offer. Phone Roger at (507) 359-2488.

Meade GEM Owners —
Celestron Polaris Owners —
Dec. motor now available with hand unit attachment. Turn your single-axis into dual-axis!
VISA MasterCard
$98.50 ppd. Specify GEM, Polaris or Super Polaris
JIM'S MOBILE IND., 1960 Co. Rd. 23
Evergreen, CO 80439 — (303) 277-0304

TOP DOLLAR PAID FOR YOUR USED EQUIPMENT
USED MERCHANDISE HOTLINE
800-223-2500
ADORAMA
138 WEST 34th STREET
NEW YORK, N.Y. 10001
WANTED TO BUY— Used telescopes, Cat lenses and other photographic equipment. Send us your equipment for evaluation and we will call you with our offer. If no deal is made, we will send back your equipment at our expense.
BE SURE TO INCLUDE YOUR PHONE NUMBER
SEE OUR OTHER ADS ON PAGES 94-95

Telrads®



VISA • MC
CHECK
$44.50
Ingenious finder easily and quickly locates any reference point in the sky, without setting circles or polar alignment and images are always erect!
astro•tech
101 WEST MAIN ■ P.O. BOX 2001
ARDMORE, OKLAHOMA 73402
405/226-3074
30 Day Money-Back Guarantee!

SPACE*SHIRTS
BEAUTIFUL FULL COLOR IMAGES OF DEEP SPACE
ON OUR HIGHEST QUALITY CUSTOM DESIGN T-SHIRT
#A101 - ANDROMEDA GALAXY
#A102 - HORSEHEAD NEBULA
#A103 - LOS ANGELES, EARTH
#A104 - THE ORION NEBULA
#A105 - DEEP SPACE COLLAGE
•SWEAT SHIRTS ALSO•
New Printing Technology Brings the Beauty of Deep Space Color Photography to Shirts.
•All on white shirts•
ONE T-SHIRT............$12.95
ONE SWEAT SHIRT....$21.95
$1.00 off each for 2 or more
SPECIFY: S M L XL
or youth size: Large only
Postage and Handling: $1.50 for 1-3 T-shirts. Each addl. add 50¢
Sweats: $1.50 for one. 50¢ each addl.
Overseas: add $1.00 per shirt
MASTERCARD & VISA accepted
(include number & expiration date)
WRITE FOR FREE BROCHURE
SCIENCE & ART PRODUCTS P.O. BOX 1166
MALIBU, CA 90265 • (213) 456-2496

SPACE VIDEOS
The finest in NASA Films
THE EARLY DAYS
The beginning
Freedom 7
Friendship 7 1 hr., 46 min.
GEMINI
Gemini XII, IV, VI, VII, VIII
2 hours
APOLLO
Apollo 8, 11, 15 & 17
1 hr., 47 min.
SPACE SHUTTLE
First four test missions
Columbia missions
STS flights 5, 6, 7 & 8
1 hr., 56 min.
UNIVERSE & SPACE EXPLORATION
Universe, Earth/Sun relationship
Jupiter Odyssey, Mercury & Mars
1 hr., 55 min.
Each $39
4 for only $139
All 5 .... $149
plus $5 s/h
Order Toll Free
(800) 437-0800 in CA (800) 437-0888
Hayes & Nolly Productions
3000 Alamo Drive, Suite 206
Vacaville, CA 95688
VISA MASTERCARD AMEX
Specify VHS or BETA

A Special Message To RETAILERS!

ASTRONOMY
Celestial Views of Planet Earth

Imagine the benefits of drawing regular customers into your store once-a-month, every month. Imagine adding a hobby product to your store that's profitable, popular, and fully returnable! By stocking ASTRONOMY, you'll accomplish both!
If you're not already stocking ASTRONOMY, call us toll-free and we'll let you know how we can work for you!
CALL TOLL-FREE 800-558-1544
(Dealer inquiries only)
Kalmbach Publishing Co., 1027 N. 7TH ST., Milwaukee, WI 53233

☐ Criterion ☐ Meade ☐ B&L ☐ Edmund ☐ Tele Vue
Bushnell ☐ Mirador ☐ Minolta ☐

Criterion RV6
Send new catalog & info on products checked:
name
address
city state zip
TBR Optical
850 Hudson Ave; PO Box 17129, Roch., NY 14617
(716) 544-2162

FOR SALE — Meade model 2120 LX2, 10" Schmidt Cassegrain. Like new. Wedge, tripod, dew shield, four eyepieces. $1,600 firm. Pick up in central Connecticut. Contact Peter Marut, 4 Four Rod Road, Kensington, CT 06037. Phone (203) 828-9593.

FOR SALE — Celestron C102F fluorite refractor on Super Polaris mount. Standard accessories. Never used. $1,800 or best offer. Contact Mark Coco, 1120 Ysabel Street, Redondo Beach, CA 90277. Phone (213) 316-6940.

FOR SALE — ASTRONOMY back issues. January-November 1985 and January-December 1986 in annual hardcover binder. Excellent condition. $45 post paid for all or $25 each year separately. Contact Lorrie Marchini, Route 1, Box 51, Penrose, NC 28766.

FOR SALE — ASTRONOMY and *Sky and Telescope* back issues. 1983-1987. $24 per year. Seven volume files. $5 each. All in excellent condition. Contact Dan R. Hieb, 120 South Sanborn, Chamberlain, SD 57325. Phone (605) 734-5704.

FOR SALE — CT-100 Coulter 4-1/2" reflecting telescope. Equatorial mount, field, and table top legs. Optics fold into leather camera case. Like-new condition. Not in production. $230 or best offer. Contact Peter Parker, 1929 Meadowbrook Road, Altadena, CA 91001. Phone (818) 794-6432.

FOR SALE — Super C8 Plus with Starbrite coatings and accessories. $1350. 13" Newtonian. $550. 4-1/2" equatorially mounted Newtonian. $220. Many eyepieces and accessories. Contact Theodore R. Stout, 2146 Pinnacle Court, Fort Wayne, IN 46815. Phone (219) 749-1841.

FOR SALE — 2080 Meade, MCSO, LX drive, wedge, tripod, 8x50mm finder, enhanced star diagonal, digitrak dual-axis drive corrector with DEC motor, motofocus, porta pac., piggyback bracket, dew shield, tube balance weight system, precision polar axis finder, off-axis guider, master guide reticle system, T-adaptor, tele-extender, Brandon 8mm and 24mm Erfle oculars, TeleVue 13mm and 17mm Plossl oculars, and samsonite case. $1750. Contact Roger Black, 2409 Trail Tree Court, Burleson, TX 76026. Phone (817) 295-4696.

FOR SALE — Unitron 4" model, 152 equatorial refractor, 10x-42mm view finder, slow-motion controls for R.A. and dec., setting circles, tripod, Sun projecting screen, 40mm mono ocular, 18mm Ortho ocular, 32mm 2" Erfle ocular, 50mm 2" Ortho ocular, TeleVue 2.5x Barlow, wooden cases. $1,750. Contact Roger Black, 2409 Trail Tree Court, Burleson, TX 76028. Phone (817) 295-4696.

FOR SALE — Good size collection of space videotapes, including the actual live coverage of the *Challenger* explosion. Send SASE for list of tapes. Contact Pat Riley, 109 Djeddah Drive, Lawrenceburg, KY 40342.

FOR SALE — 30-pound meteorite from Odessa, Texas. Beautiful display specimen. Iron meteorite with many depressions and several deep cavities. $1,600. Contact Tom Coughlin, 1907 Tower Bridge Terrace, St. Louis, MO 63146. Phone (314) 878-4979.

FOR SALE — Vintage 1969 10" f/13.5 Celestron, serial no. 120. Mint condition. Extras. $3,000. WWII German 10x80 binoculars, angle eyepieces, yoke mount, metal tripod, original box. $1,000. 4" f/5 telephoto/telescope. $350. Contact Sheldon Faworski, 9411 Knoll Top Road, Union, IL 60180. Phone (815) 923-2602.

FOR SALE — Celestron 8" Schmidt camera, two film holders. $1,200. Contact Porter Kier, Ospray Point, Lottsburg, VA 22511. Phone (804) 529-6071.

FOR SALE — Tripod and heavy-duty equatorial mount for 60mm refractor. $100. Meade 2x Barlow. $40. Bronze gear wheel, 180 teeth, 2" center with worm, never used. $400. Contact Bob Spencer, 2532 Renzoni Road, Mississauga, Ontario, Canada, L5K 1W9. Phone (416) 823-7877.

FOR SALE — Complete set of ASTRONOMY. Fourteen years. Mint condition. $350. Contact Thomas J. Dooley, 975 Teaneck Road, Teaneck, NJ 07666.

FOR SALE — 35mm Olympus OM-1 camera with T-mount adaptor for standard telescope eyepiece mount, 1.4 lens. $225. Astroscan and tripod bracket. $210. Six cartoon Christmas cards with Apollo program/KSC background themes. $5. Contact Joe Funke, Star Route, Lake Como, PA 18437.

FOR SALE — 10" f/4 Schmidt Cassegrain, fully equipped. 2" center perforation, full thickness, 1/20-wave hand-figured Richard Fagin optics. C90, 60x900mm refractor. Newtonian easyguider, 3x diagonal. Books, magazines, and more. SASE. Contact C. Perillo, 45 SW 17 Avenue, Homestead, FL 33030. Phone (305) 245-3028.

FOR SALE — Celestron C14 with many improvements and extras. 8" f/10 Newtonian with Parks mount. Several oculars and accessories. Lots of great books. Selling everything. For complete list and prices contact Charlie Humphrey, 2104 White Street, Alexandria, LA 71301. Phone (318) 487-4903.

FOR SALE — 155 different ASTRONOMY back issues. Mostly mint condition. August 1973-March 1987. $200. I'll pay postage. Contact Ronald Chavin, 1063 Lunaanela Street, Kailua, HI 96734.

FOR SALE — Odyssey 8" f/4.5 telescope. Complete with Dobsonian mount and one 27mm eyepiece. $125. Phone (919) 443-9848.

CANADA

BUSHNELL
Meade
TeleVue
CELESTRON
VE DIGITRAK
Bausch & Lomb

Criterion 4000 Telescope Observatory System

SCOPE CITY

We Ship Anywhere

247 MARLEE AVE. UNIT 201
TORONTO, ONTARIO, CANADA
M6B 4B8
(416) 783-4140

Catalogue $ 3.00

Not associated with Scope City of California

FREE
Catalog & Photo
SPACE
CATALOG

The official catalog of the National Space Society offering the finest space-related products: artifacts, books, clothing, memorabilia, murals, patches, posters, slides, space art, videos and many other items. For a FREE copy of the SPACE CATALOG and a 8" × 10" Color Photo of "Untethered in Space" or a 17" × 22" Color Poster of the "Space Operations Center" send $2.00 (to cover postage & handling)

SPACE CATALOG, Dept A, 922 Pennsylvania Ave SE, Washington DC 20003.

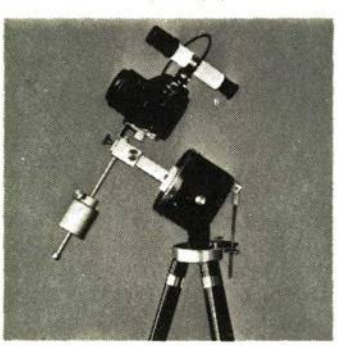
(Be sure to indicate "photo" or "poster". Orders outside North America send $5.00 in US funds only.)

The International Space Center · 922 Pennsylvania Ave. SE · Washington, DC 20003

Clockwork Rotation Mechanism

for 35 mm and similar cameras.
Astronomical Photography without a Telescope.
Neither plug nor battery needed.
The only clockwork device of its type in the world.
2 Models:
Model I can be fitted to any commercially available photo tripod
Model II is mounted on a special tripod

A West German quality product.



PURUS-ASTRO-MECHANIK, Postfach 31
6800 Mannheim 71, West Germany

DISTRIBUTOR & AGENT FOR U.S.A.
EVERT ACHTERBERG
P. O. Box 123, Escalon, CA 95320
Phone: (209) 838-1259
Write or phone for free catalog.

— Dynamax 8 • B & L 8000 —

Motofocus now available . . **$98.50 ppd.**
Snap-on Motodec . . . . . . **$69.95 ppd.**

MasterCard Order both and get dual control hand unit **FREE!** VISA

JIM'S MOBILE IND., 1960 Co. Rd. 23
Evergreen, CO 80439 — (303) 277-0304

Telescopes • Binoculars • Astro-Aids

— Catalogs $3.00 —

We will not be undersold!

PAULI'S WHOLESALE / DISCOUNT OPTICS
29 Kingswood Rd., Danbury, CT. 06811,
Tel. 203-746-3579

Meade
THE LEADER'S EDGE

8X50 Finders

Right Angle With
Straight Adapter

Only $\$59^{95}$

Celestron. Original equipment on SC8's. Twist-Focus. Classic Black. New!
Mounting Brackets: Newtonians - $22.50
C8/2080 (specify) - $37.50, or make your own.
VISA • MC • CHECK

astro-tech
101 WEST MAIN ■ P.O. BOX 2001
ARDMORE, OKLAHOMA 73402
405/226-3074

30 Day Money-Back Guarantee!

FOR SALE — Celestron 9mm and 12mm Orthoscopic eyepieces. Excellent condition. $40 each or $75 for both. Contact Peter Turkowski, P.O. Box 144, Central Square, NY 13036.

FOR TRADE — Observing reports and information from amateurs concerning the Sun. Have observed the Sun for one year. Also interested in 1985/1986 period. Contact Peter Mansky, Box 50, 271 00 Ystad, Sweden.

St. James' House

4142 West Peterson
Chicago, Illinois 60646 USA

Dealers in fine antique clocks, astronomical, navigational surveying and medical instruments, artwork and books.

Catalogue available $5.00

SALES • REPAIR • RESTORATION
(312) 545-0011

omcon

ST NEWTONIANS AND REFRACTORS

OMCON 515 ST 6" f/5 NEWTONIAN	**$495.00**
OMCON 715 ST 6" f/7 NEWTONIAN	**$495.00**
OMCON 158 ST 3" f/15 REFRACTOR	**$425.00**
OMCON 708 ST 3" f/7 4-ELEMENT	**$495.00**

ALL MODELS INCLUDE:

- EQUATORIAL MOUNTING WITH ACCESSORY TRAY, SLOW MOTION CONTROLS AND POLAR AXIS
- DIFFRACTION LIMITED OPTICS, SETTING CIRCLES, ALL METAL CONSTRUCTION AND MORE!
- MOTOR DRIVE **$49.00** ACCESSORIES AVAILABLE

NEW! 50 PAGE CATALOG $3.00

OMCON PRODUCTS
1190 BALDY MTN LANE • BELGRADE MT59714
SKY INSTRUMENTS
MPO BOX 3164 • VANCOUVER, B.C. V6B 3X6
CANADA Ph. (604) 270-2813

THE "HIGH-LIGHT"™ BINOCULAR SYSTEM QUALITY 11 x 80 GIANT BINOCULARS AND A PERSONAL SUPPORT DEVICE FOR FATIGUE-FREE, BRIGHT, CLEAR STEADY IMAGES. (PATENTED)

FOR ILLUSTRATED BROCHURE, CALL OR WRITE
CELESTIAL INNOVATIONS. HCR BOX 3228,
DEPT A, ORACLE, AZ 85623 (602) 896-9109

CHALLENGER ACCIDENT VIDEO

29 minutes • Full Color • Produced by NASA
Distributed by RICON Enterprises: $27.45 postpaid

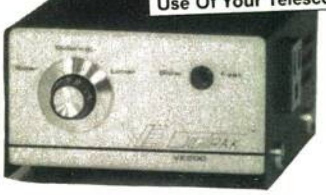
Using computer drawings, still photos, real-time & slow motion computer enhanced video, this program is a summary of the data analyzed by NASA and explains in microscopic detail the events that led to CHALLENGER's destruction. For a brochure describing this and other Space Shuttle videos: send SASE to address below.

RICON Enterprises
5863 Village Forest, Dept. **A**
Houston, TX 77092

Specify VHS / Beta
Allow 4-8 weeks delivery
Add $2.50 shipping to Canada

ASTROPHOTOGRAPHERS!

Portable Power For Field Use Of Your Telescope



Quartz Controlled Drive Correctors

Digitrak uses state of the art technology for true digital control. Unlike ordinary drive correctors that use a quartz reference, Digitrak "quartz locks" the desired tracking speed.

Porta Pac
$59.95
(plus shipping)

Call or Write for **FREE BROCHURE**

Vogel Enterprises, Inc.
P.O. Box 3717, Oak Park, IL 60303
1-800-457-TRAK (IL: 1-312-456-TRAK)

"If a journey around the world changes a person. . .
then a journey 200 times around the world
at the speed that a spaceship travels
changes a person even more." Joe Allen, astronaut

SEVEN DAYS IN SPACE

(A week aboard Space Shuttle "Discovery")

The first home-video documentary shot, almost entirely, in space.

- **Background notes supplementing the video**
- **Footage never before seen by the public!**
- **88 minutes of being there!**
- **Narrated by the crew of mission 51-A**

Launch into orbit on a tour of the Space Shuttle and its capabilites, guided by the astronauts and controllers of "Discovery," on the mission that returned two defective satellites to Earth. Become weightless, deploy new communications satellites, gaze back at your planet, strap on the Manned Maneuvering Unit and "Stinger," and take the ride men have dreamt of for thousands of years!

HV
HALCYON VIDEO

To order send name and address + check or money order for $29.95 + $3.00 for postage and handling to:

Halcyon Films and Video
110 Beach Road, Box D3
Kings Point, New York 11024
or call
1 • 800 • 821-2102
Specify VHS or BETA

SOFTWARE For YOUR
APPLE IIe/IIc/IIgs IBM PC/XT/AT C64/128

★ASTROCALC™★ Input time, date and location and ASTROCALC gives you for Sun, Moon, and all the Planets: R.A. & Dec., Alt & Az, Ecliptic Lat. & Long., Angular size, Phase, Elongation., Orbit Elements, Rising and Setting Times, Magnitudes, Local Sidereal Time, GMT, GST, Julian Day Number, Equation of Time, Inclination, Eccentricity, Ascend. Node & More., Fundamentals of Theory included in Manual. **Thousands of Satisfied Users, Worldwide** **$29.95**

★ASTROSTELL™★ Learn all 88 constellations! Four levels of star brightness simulate sky on screen. Gives star names, positions of galaxies, nebula, etc., plus lore and observing tips. 80 column screen. **"A Perfect Delight"-Prof. M.F., Minn. IBM or Apple only** **$29.95**

★ASTROBASE™★ Astronomical database of the 300 most important deep-sky objects. User can enter hundreds more. Includes Galaxies, Clusters, Nebulae, Double & Variable stars, Messier objects, Best from Burnham's handbook & more. Does searches, displays, prints out. Gives objects visible for your time/location. Log information on observations. Manual with intro to deep-sky objects. IBM or Apple only. **$29.95**

★ASTRO-AID™★ Integrated Software Package for Astronomical Work. In Easy-To-Use menu-driven program you get: **Time Conversions-**Julian,Gregor.,Sidrl,UT,ET,Solar; **Coordinate Conver.-**Equatorial,Eclip,Galactic,Alt-Az; **Precession; Nutation; Aberration; Parallax; Refraction; Telescope Design-**Resolution,Coma,Diag. Size,Etc; **Equinox; Solstice; Polaris Transit; Jupiter's Moons; Solar System Data-**Sun,Moon,Planets,Satellites. Comes complete with User's Manual **$29.95**

★ASTROFINDER™★ Turns your computer into a planetarium & chart maker. Shows night sky on screen in realistic simulation. Prints star charts on any graphics printer. Includes Messier objects, deep-sky objects, planet tables and more! Detailed manual with star atlas. 30 page star catalog on screen or print out. For IBM & compatibles with CGA or EGA graphics. **$69.95**

ORDER TODAY!

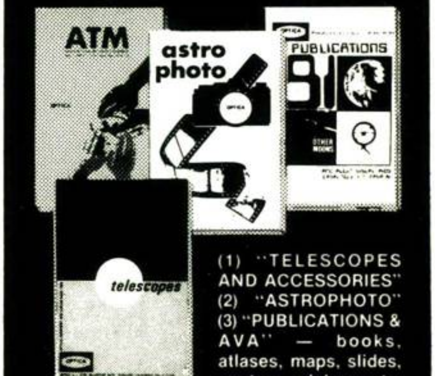
1-800-533-6666 9-9, Mon-Sat Orders Only
For Info or in PA call 412-422-6600

By phone or mail. Check, M.O., credit card (# & Expir.). Add $2 shipping ($4 overseas). PA add 6%. **JOIN OUR THOUSANDS OF SATISFIED CUSTOMERS in 50 states & over 70 countries!**

ZEPHYR SERVICES

1900 Murray Ave. Dept. B
Pittsburgh, PA 15217
FREE Catalog - call or write
OUR 6th YEAR OF BUSINESS

4 OPTICA b/c CATALOGUES



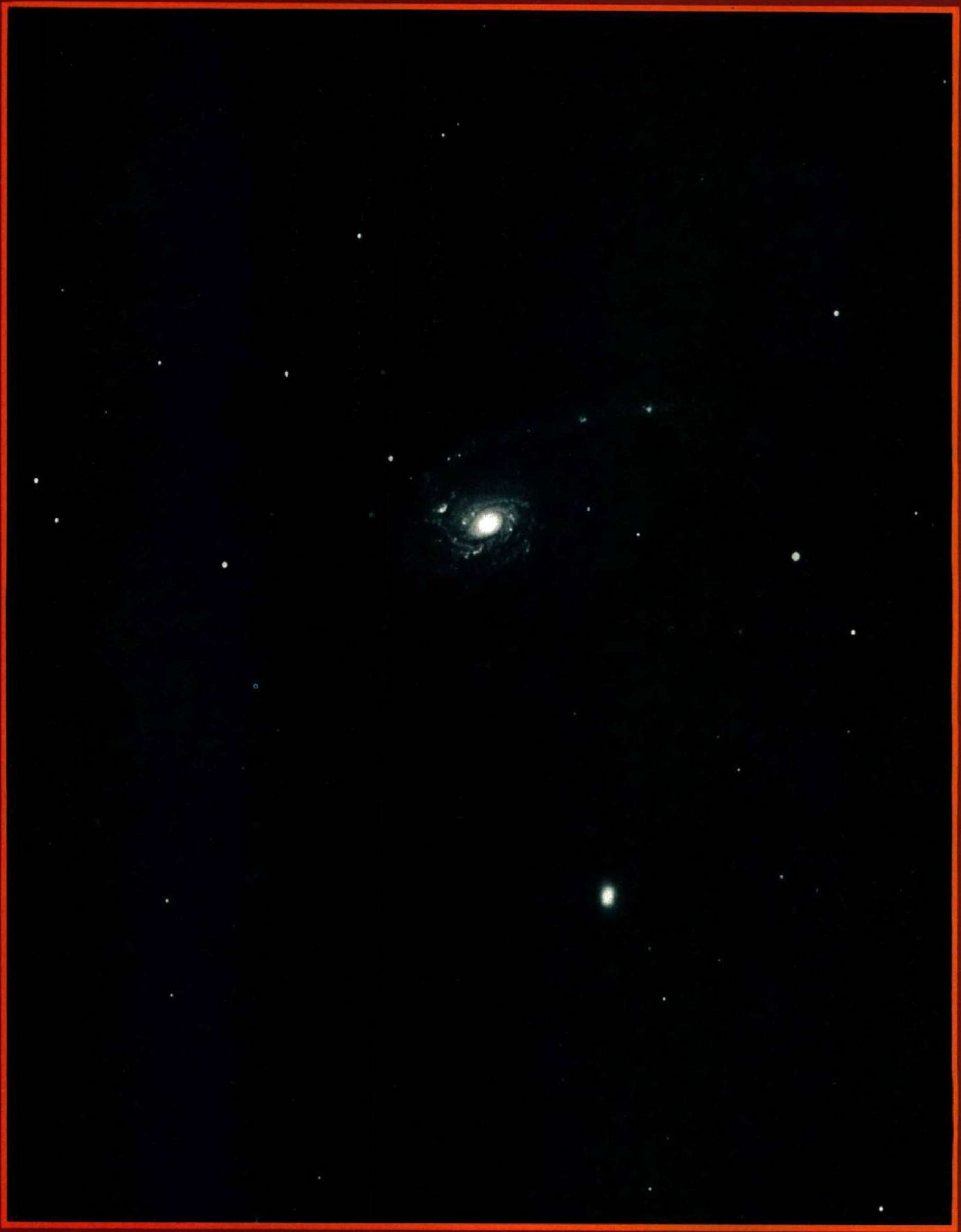
(1) "TELESCOPES AND ACCESSORIES"
(2) "ASTROPHOTO"
(3) "PUBLICATIONS & AVA" — books, atlases, maps, slides, posters, globes, etc.
(4) "ATM" — goods for telescope making.

Over 100 pages · 2,000 items · a wealth of useful information · many exclusives not available from any other source in the USA. Each catalog · $2.00; all four · $5.00 · Foreign add $5.00. Also Receive: FREE Astro Events Calendar · Meade, Celestron and B&L discount price lists. Others: Astro Aids, Stellar Ventures, Von Werner and Bushnell. Binocular & Telescope repair and service: collimating, aluminizing, etc.

Astro equipment and supplies since 1939

OPTICA

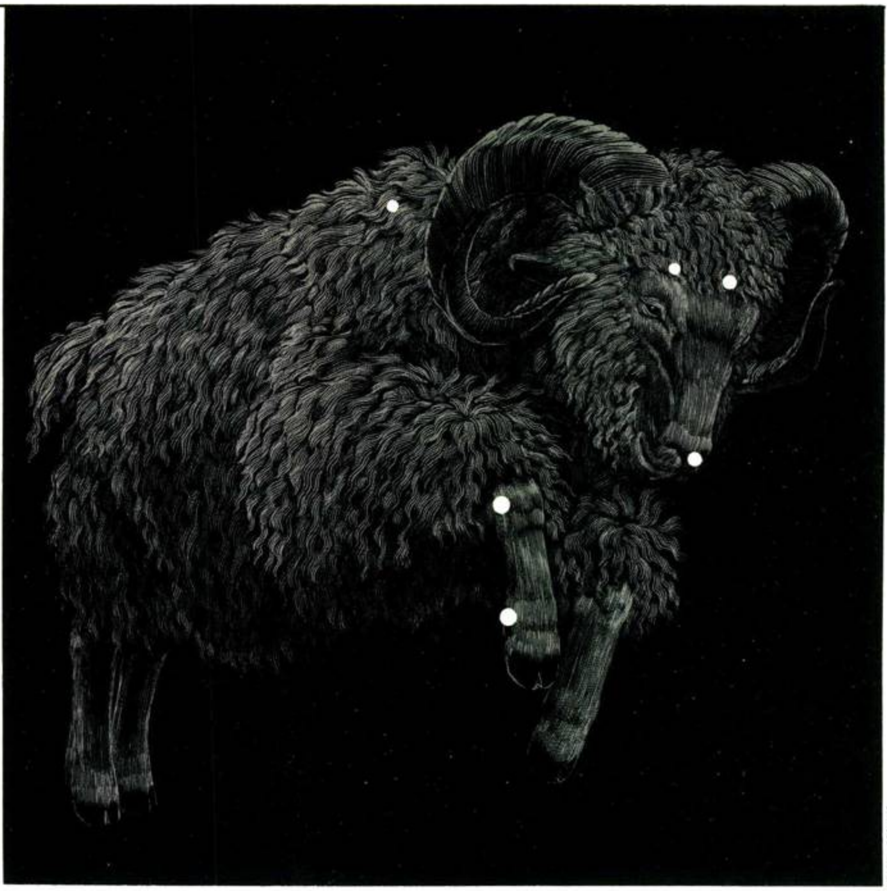
OPTICA b/c Company
ASTRONOMY DIVISION
4100 MacArthur Blvd., Oakland, CA 94619



NGC-772 is a magnitude 10.3 spiral in Aries, visible in backyard scopes as a bright core surrounded by a diffuse halo of nebulosity. The little galaxy to its southwest is NGC-770, a 14th-magnitude elliptical system. U.S. Naval Observatory photograph.

Aries

Ari
Arietis


Keith Ward

Lying in a rather barren part of the sky between the constellations Triangulum and Cetus, **Aries** the Ram is an inconspicuous group of stars. Aries is composed of a single 2nd-magnitude star, one 3rd-magnitude star, and a handful of 4th- and 5th-magnitude stars. The constellation also contains several deep-sky objects. Those it does hold include a dozen widely scattered galaxies and two bright double stars.

The largest and brightest galaxy in Aries is **NGC-772**, a magnitude 10.3 spiral measuring 7.1′ by 4.5′. This galaxy is relatively easy to find because it lies slightly less than 2° east-southeast of the 4th-magnitude star Gamma (γ) Arietis. (The galaxy forms a right triangle with Gamma and the 5th-magnitude star Iota (ι) Arietis, some 2° south of Gamma.)

Small telescopes show NGC-772 as a gray, oval haze some 2′ or 3′ across. A 4-inch scope at high power reveals the galaxy's bright, condensed, ball-like nucleus centered in the nebulous envelope representing the spiral arms. An 8- or 10-inch telescope shows a star just off the galaxy's western side and under good conditions may faintly show the galaxy's spiral arms or at least the brighter northwestern arm. Large scopes in the 16-inch and larger class show the galaxy as a large oval smudge of light superimposed over a bright, almost starlike nucleus and a ghostly spiral arm pattern.

If you observe NGC-772 with a large scope, you may also spot **NGC-770** in the same field of view, 5′ south of the spiral. NGC-770 is an elliptical galaxy some 1.3′ by 1.0′ across with a blue magnitude of 14.1. This object appears as a tiny, fuzzy, out-of-focus "star" at low power. At high power during good seeing it shows as a pale patch of nebulosity with a slightly brighter middle.

After you observe NGC-772, move your telescope back to the bright star **Gamma Arietis**. With a low-power eyepiece you'll see that Gamma is a wide double star with equally bright components (each shines at magnitude 4.8). Separated by 7.8″, Gamma's stars are resolvable with any telescope and generally considered one of the prettiest equal pairs, each star a sparkling blue-white. Gamma Arietis was one of the first known double stars, found accidentally by the English scientist Robert Hooke in 1664 while he was searching for a comet. Gamma Arietis is a relatively close pair of stars lying some 50 parsecs away. The combined luminosity of the two stars equals about fifty Suns.

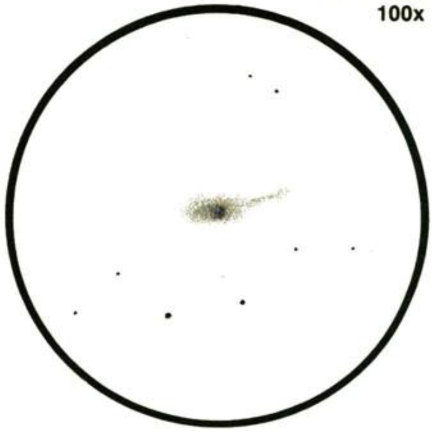
For information on naked-eye sky viewing, including planets, constellations, and mythology, see **Eye on the Sky**.

South of the Gamma Arietis area lies another galaxy. **NGC-877** is relatively easy to find by star hopping: point your telescope toward Gamma; move it southeast to Iota; move it an equal distance east to a wide, flattened triangle of 6th-magnitude stars; and then follow the arc of the triangle south to 19 Arietis. Now simply move the finder scope 1.5° southeast, and you should see two 8th-magnitude stars positioned east-west. With a low-power eyepiece, center the telescope's field of view on the easternmost of the two stars, and you should see the galaxy and the star. With an 8-inch telescope NGC-877 appears as a small, round patch of grayish nebulosity some 1.5′ across the center and slightly brighter than the surrounding light. A star lies on the galaxy's southeastern side and a slightly fainter star lies on the northwestern side. Larger telescopes don't dramatically improve the view, though they do show a larger area of nebulosity and hint at mottling across the galaxy's face.

Some 4° southwest of NGC-877 near the southern border of Aries is the bright elliptical galaxy **NGC-821**. To locate this galaxy, aim your finder scope toward Xi (ξ) Arietis, the brightest star in a semicircle of six stars on the Aries/Cetus border. Next, with a low-power eyepiece move the telescope 4° west and 30′ north, and you should see an oval smudge of light in your eyepiece. A 4-inch scope shows this magnitude 10.8 galaxy as a nebulous smear spanning 3′ by 2′ with a 10th-magnitude foreground star on the galaxy's northwest side. An 8-inch scope reveals that NGC-821's surface is not uniformly illuminated but slightly mottled.

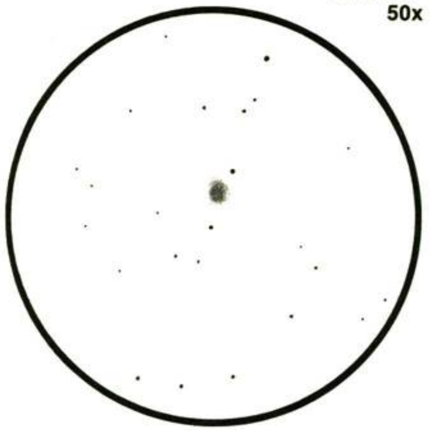
Midway between NGC-821 and NGC-772 lies the small Sb-type spiral **NGC-803**. This galaxy softly glows at magnitude 12.4 and covers 3.3′ by 1.5′. A 4-inch scope shows NGC-803 as a thin, dim spike of gray-green nebulosity, and a 6-inch scope shows it as an elongated patch of nebulosity with a bright center. An 11th-magnitude star lies just to the galaxy's west side.

The northwestern corner of Aries holds two more galaxies visible in small telescopes. **NGC-697** is a highly inclined barred spiral with a photographic magnitude of 12.7. To locate this galaxy, place



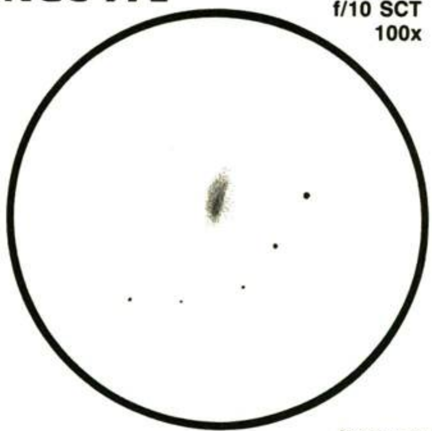
NGC-772

8-inch
f/10 SCT
100x



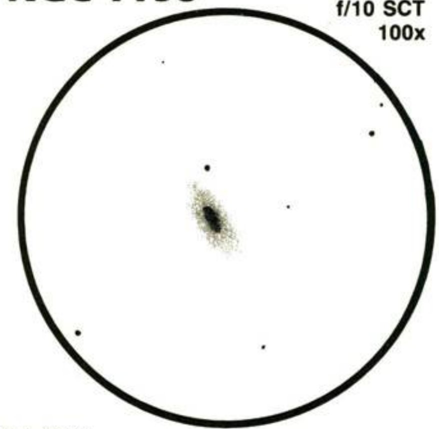
NGC-821

8-inch
f/10 SCT
50x



NGC-972

8-inch
f/10 SCT
100x



NGC-1156

8-inch
f/10 SCT
100x

Sketches by David J. Eicher

your finder scope on the 3rd-magnitude star Beta (β) Arietis and move 2° to the northwest. This will bring you to a 6th-magnitude double star cataloged as 1 Arietis. NGC-697 lies to the east, just outside of a low-power field centered on this wide double. Six-inch telescopes show NGC-697 as a relatively bright, spindle-shaped patch of light elongated east-west with a 12th-magnitude star off the galaxy's eastern arm. Now move back to 1 Arietis and position your scope on a 10th-magnitude star 45′ south of the double. This brings you to **NGC-691**, a spiral glowing at blue magnitude 12.4 and measuring 3.5′ by 2.7′. This object appears as a low surface brightness haze with a bright, condensed center just southwest of the 10th-magnitude star.

In north-central Aries some 2° southwest of the 5th-magnitude star Nu (ν) Arietis lies the small spiral galaxy **NGC-976**. This galaxy glows softly at magnitude 12.4 and measures 1.7′ by 1.5′. It has a relatively low surface brightness, so it appears in a 6-inch telescope like a small, nebulous patch without detail.

Seven degrees northeast of NGC-672 is the irregular galaxy **NGC-1156**. This galaxy is observationally interesting because it shows mottled detail in small telescopes and lies in a rich starfield. To locate NGC-1156, start by centering your finder on the 4th-magnitude double star 41 Arietis in the northern part of Aries. Move the telescope 3° east-southeast to a bright pair of stars called 49 and 51 Arietis. Note the bright double star southeast of this pair. This is 52 Arietis. The galaxy forms an equilateral triangle with the 49/51 pair and 52, and represents the triangle's southwestern corner.

When you zero in on NGC-1156, you'll see it lies inside a much smaller equilateral triangle made up of 9th- and 10th-magnitude stars. The galaxy lies between one of these stars and a row of three 12th-magnitude stars; a faint star lies on the northwestern edge of the galaxy. Small scopes show NGC-1156 as an oval blob of light with a bright middle, surrounded by an irregularly shaped halo of faint light. On nights of good transparency 8-inch scopes show patchy mottling in this halo, and 12-inch and larger scopes regularly show a grainy, uneven texture in the nebulosity.

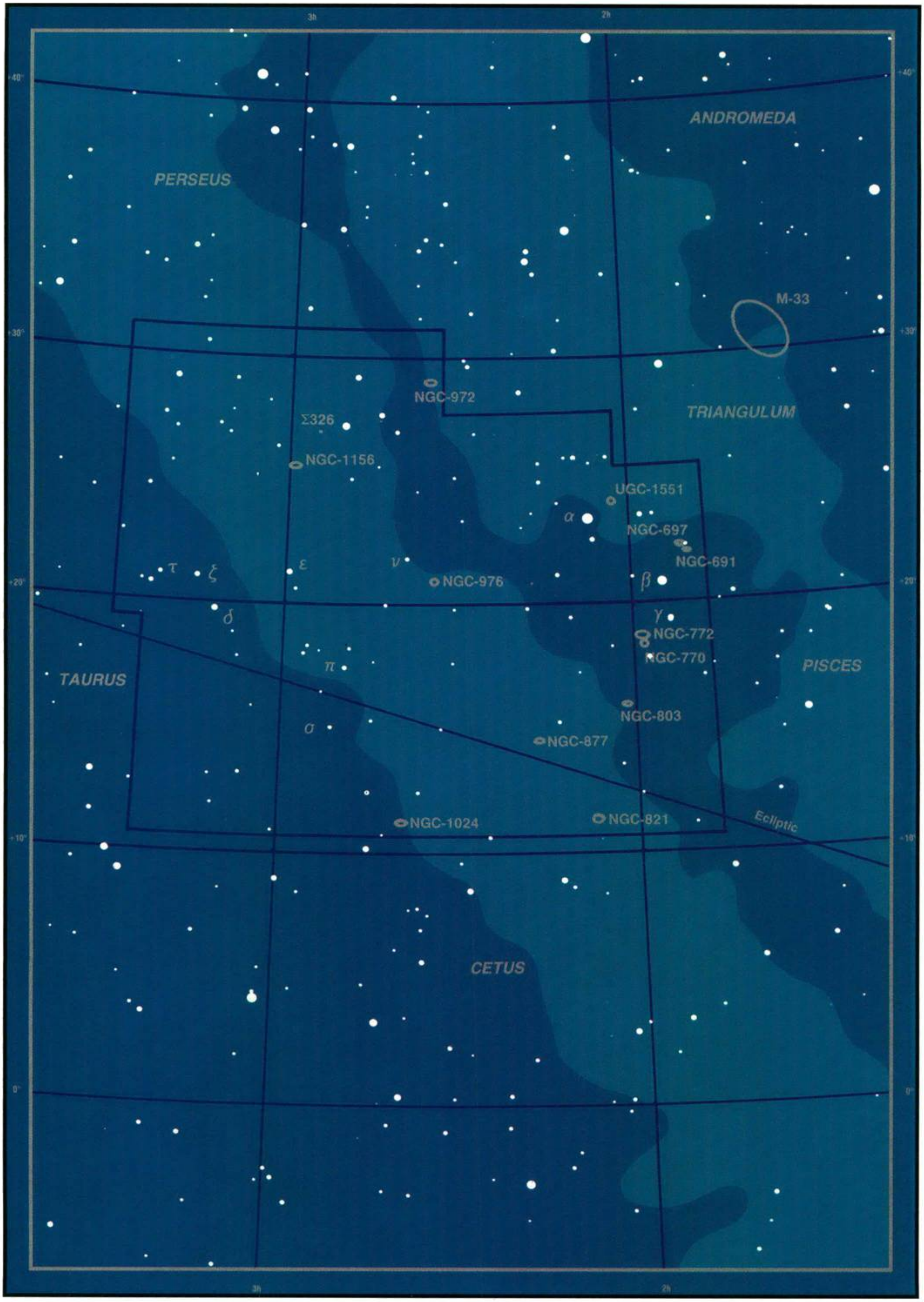
Also in the northern part of Aries is **NGC-972**, an 11th-magnitude highly inclined spiral measuring 3.6′ by 2.0′. To find this object, start at the bright double 41 Arietis and move 3° northwest through 35 Arietis, but not as far as the pair of 6th-magnitude stars 12 and 13 Trianguli. You'll see a close pair of 7th-magnitude stars oriented nearly north-south; the galaxy lies 30′ west of this pair. Visually NGC-972 appears as an elongated smudge of bright nebulosity just north of a faint double star. NGC-972 has a bright middle and a large, faint envelope of surrounding nebulosity.

Object	M#	Type	R.A. (2000)	Dec.	Mag.	Size/Sep./Per.	H
NGC-691		§	1h 50.7m	+21°46′	12.4_B	3.5′x 2.7′	Sb$^+$
NGC-697		§B	1h 51.3m	+22°21′	12.7_P	4.7′x 1.8′	S(B)b$^+$:
Gamma (γ)		★^{2}	1h 53.5m	+19°18′	4.8,4.8	7.8″	
NGC-770		0	1h 59.2m	+18°57′	14.1_B	1.3′x 1.0′	E3:
NGC-772		§	1h 59.3m	+19°01′	10.3	7.1′x 4.5′	Sb
UGC-1551		§B	2h 03.6m	+24°04′	13.3_B	3.0′x 1.5′	SBdm
NGC-803		§	2h 03.8m	+16°02′	12.4	3.3′x 1.5′	Sb
NGC-821		0	2h 08.4m	+11°00′	10.8	3.5′x 2.2′	E2
NGC-877		§	2h 18.0m	+14°33′	11.8	2.3′x 1.8′	Sc
NGC-976		§	2h 34.0m	+20°59′	12.4	1.7′x 1.5′	Sb
NGC-972		§	2h 34.2m	+29°19′	11.3	3.6′x 2.0′	Sc
NGC-1024		§	2h 39.2m	+10°51′	13.8_P	4.7′x 1.9′	Sb
Σ326		★^{2}	2h 55.6m	+26°52′	7.6,9.8	5.9″	
NGC-1156		#	2h 59.7m	+25°14′	11.7	3.1′x 2.3′	Ir$^+$

★^{2}	*Double Star*
§	*Spiral Galaxy*
§B	*Barred Spiral Galaxy*
0	*Elliptical Galaxy*
#	*Irregular or Peculiar Galaxy*

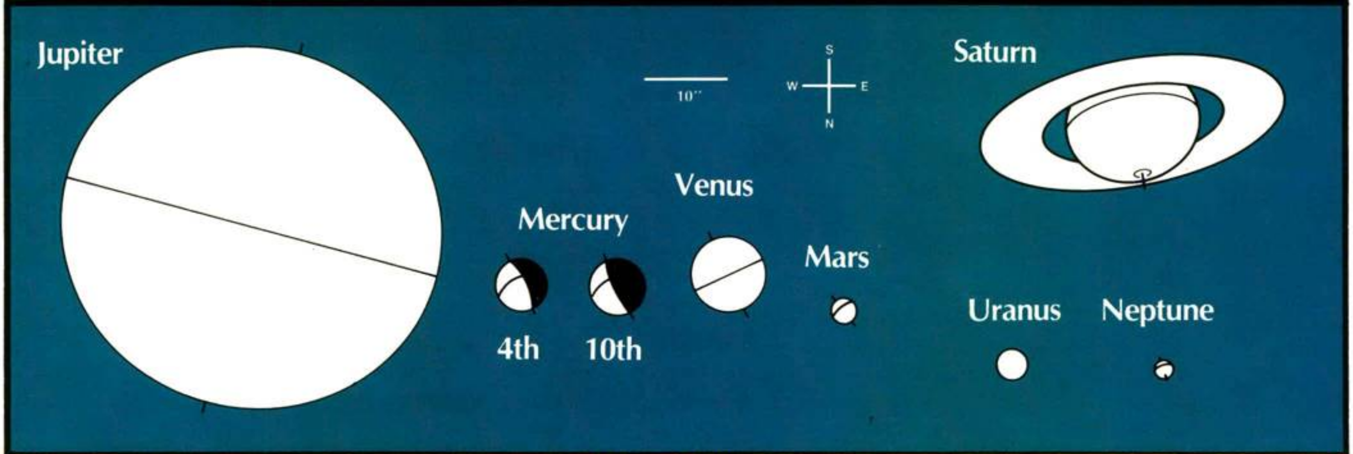
H = Hubble type for galaxies

Subscript "P" denotes photographic magnitude; subscript "B" denotes blue magnitude.

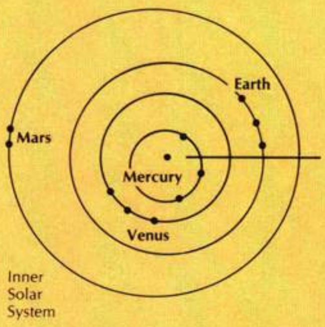

3h
2h
+40°
+40°
ANDROMEDA
PERSEUS
M-33
+30°
+30°
NGC-972
TRIANGULUM
Σ326
NGC-1156
UGC-1551
α
NGC-697
NGC-691
τ
ξ
ε
ν
NGC-976
β
+20°
+20°
δ
γ
NGC-772
NGC-770
TAURUS
π
PISCES
NGC-803
σ
NGC-877
NGC-1024
NGC-821
Ecliptic
+10°
+10°
CETUS
0°
0°
3h
2h

Planetary Data

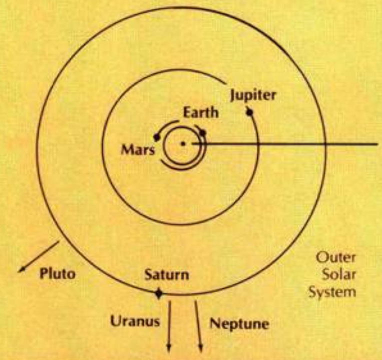
October 1987


Jupiter
10″
S
W
E
N
Saturn
Venus
Mercury
Mars
4th
10th
Uranus
Neptune

		Date	Mag.	Angular Size	% Illum.	Distance (AU) from: Earth	Sun	Longitude: Heliocentric	Ecliptic	R.A. (2000.0)	Dec.
Sun		1	−26.7	32.0′	—	1.001	—	—	187°17.5′	12h 27.4m	−2°57.6′
		15	−26.7	32.1′	—	0.997	—	—	201°06.2′	13h 18.6m	−8°17.8′
		31	−26.8	32.3′	—	0.993	—	—	217°01.9′	14h 19.4m	−13°55.0′
Mercury	☿	1	0.0	6.4″	66%	1.049	0.454	284°12.2′	212°43.4′	13h 58.7m	−14°47.9′
		15	0.5	8.3″	35%	0.807	0.394	330°44.6′	223°22.8′	14h 38.8m	−18°58.7′
		31	3.7	9.7″	3%	0.681	0.313	50°11.1′	211°26.5′	13h 56.7m	−11°49.3′
Venus	♀	1	−3.9	9.9″	98%	1.684	0.723	212°17.1′	197°54.1′	13h 07.6m	−6°04.7′
		15	−3.9	10.1″	97%	1.650	0.724	234°41.5′	215°19.7′	14h 12.9m	−12°46.3′
		31	−3.9	10.4″	95%	1.602	0.726	260°08.2′	235°15.0′	15h 31.5m	−19°10.2′
Mars	♂	10	1.8	3.6″	99%	2.601	1.660	171°35.0′	180°56.8′	12h 05.0m	0°32.8′
		20	1.8	3.7″	99%	2.566	1.656	175°59.6′	187°22.9′	12h 28.6m	−2°02.6′
Jupiter	♃	15	−2.9	49.7″	100%	3.960	4.955	24°20.6′	25°19.7′	1h 36.3m	8°19.5′
Saturn	♄	15	0.6	15.7″	100%	10.561	10.036	261°43.8′	257°11.5′	17h 04.8m	−21°35.0′
Uranus	⛢	15	5.7	3.6″	100%	19.677	19.235	266°08.6′	263°42.9′	17h 32.4m	−23°27.1′
Neptune	♆	15	7.9	2.2″	100%	30.485	30.231	277°15.8′	275°38.4′	18h 24.3m	−22°20.0′
Pluto	♇	15	13.8	0.1″	100%	30.587	29.678	219°46.6′	219°19.8′	14h 47.5m	0°19.4′


Earth
Mars
Mercury
Venus

Inner Solar System

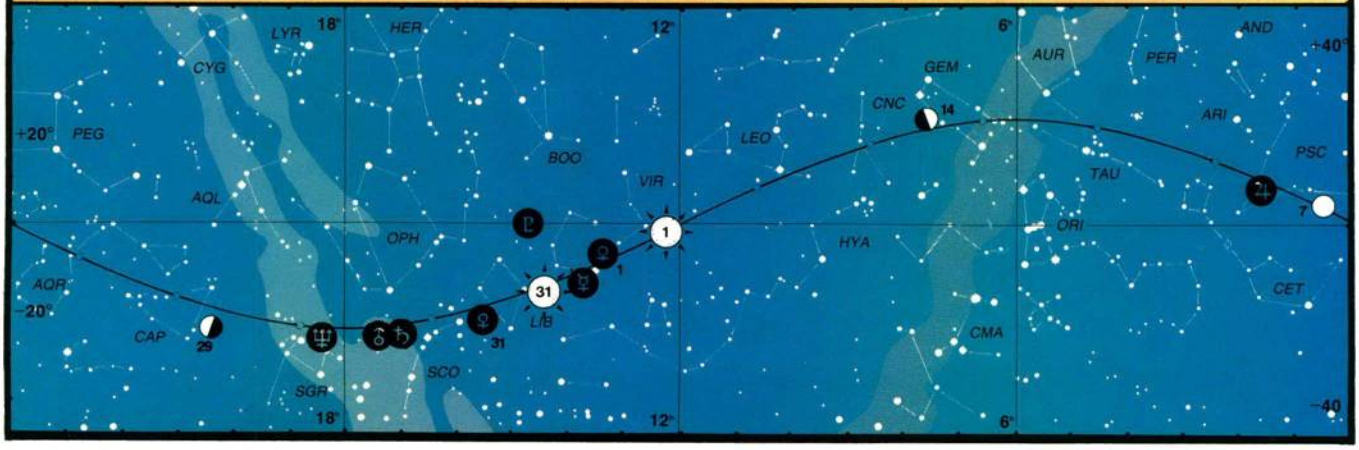

Jupiter
Earth
Mars
Pluto
Saturn
Uranus
Neptune

Outer Solar System

Moon Data

Full Moon. . . . . .Oct. 7 at 4h12m
Last Quarter. . . . . .Oct. 14 at 18h06m
New Moon. . . . . .Oct. 22 at 17h28m
First Quarter. . . . . .Oct. 29 at 17h10m
Full Moon. . . . . .Nov. 5 at 16h46m

Perigee: Oct. 4 at 0h36m UT. . . 366,025 km
Apogee: Oct. 15 at 21h23m. . . . 404,425 km
Perigee: Oct. 30 at 2h38m. . . . . 370,091 km


LYR
18h
HER
12h
6h
AUR
AND
+40°
CYG
GEM
PER
CNC
14
ARI
+20°
PEG
LEO
PSC
BOO
TAU
AQL
VIR
7
ORI
OPH
1
HYA
AQR
31
CET
−20°
CAP
29
LIB
CMA
31
SCO
SGR
18h
12h
6h
−40

This month Jupiter puts on its best show in twelve years as it reaches opposition on the 18th. A small telescope will reveal bright and dark bands, swirls, and festoons on the planet's surface. The Great Red Spot will be visible too. Shadows of Jupiter's moons will be visible crossing the planet's surface, appearing as tiny black dots at varying intervals. In this photo Ganymede's shadow is transiting the planet's disk. Photo by Jean Dragesco, who used a 14-inch f/11 SCT and Ektachrome 200 film.

Mercury

The apparition of Mercury that began last month continues through the first week of October, but viewing conditions are unremittently poor. On the date of greatest elongation the planet is less than 1° above the western horizon, forty-five minutes after sunset. You'll be better off skipping this elongation and instead plan to catch Mercury in the predawn sky next month.

Venus

In the last few days of October Venus crawls up away from the twilight glow in the west after sunset. Its magnitude of −3.9 will make Venus easy to spot (provided you have an unobstructed horizon), but its telescopic appearance will be quite unsteady because of the planet's low elevation: it is only 1° high on the 31st, forty-five minutes after sunset. The 10″ disk of Venus will appear featureless and essentially round, though viewing it before twilight fades will cut the glare enough to reveal a slightly gibbous appearance.

Mars

Mars is steadily gaining elevation in the eastern predawn sky, but its great distance from Earth (2.58 astronomical units on the 15th) means its disk remains disappointingly small. At midmonth it measures only 3.6″ across. You'll need unusually settled seeing conditions to see much more than vague, dim markings on its tiny ocher disk.

Minor Planets

1 Ceres (magnitude 8.6) is moving eastward in southwestern Sagittarius. Its positions:

1st: 17h 54m 23s, −28° 29.8′
10th: 18h 04m 46s, −28° 33.9′
20th: 18h 17m 31s, −28° 34.7′
30th: 18h 31m 21s, −28° 31.1′

Ceres sets around 9 p.m. local daylight time on the 15th.

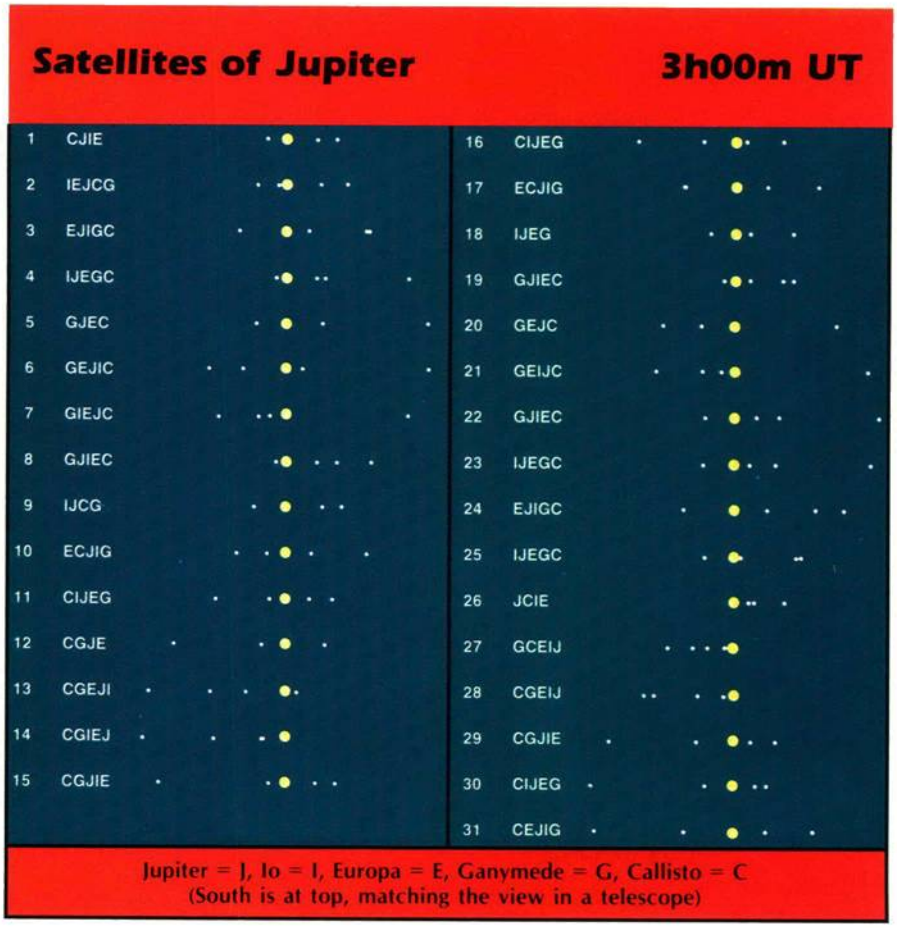
2 Pallas (10.2) is moving southeast between Hercules and Ophiuchus. Its positions:

1st: 16h 24m 37s, 9° 29.8′
10th: 16h 35m 14s, 8° 16.8′
20th: 16h 47m 42s, 7° 03.8′
30th: 17h 00m 44s, 5° 59.7′

Pallas sets about 11:30 p.m. local daylight time on the 15th.

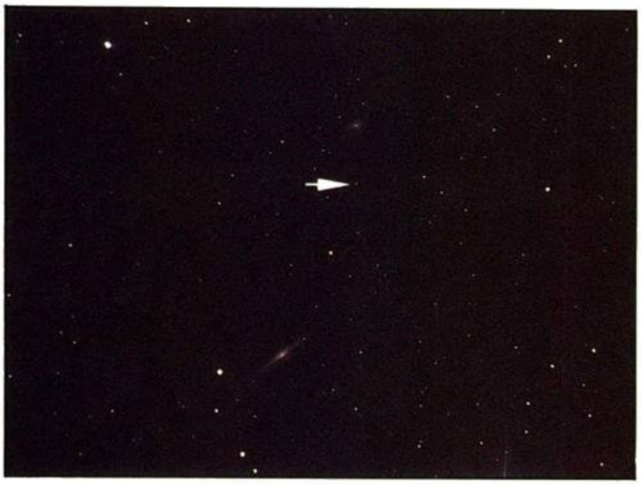
3 Juno (9.0) lies near the western tip of the Capricornus "shield." Its positions are:

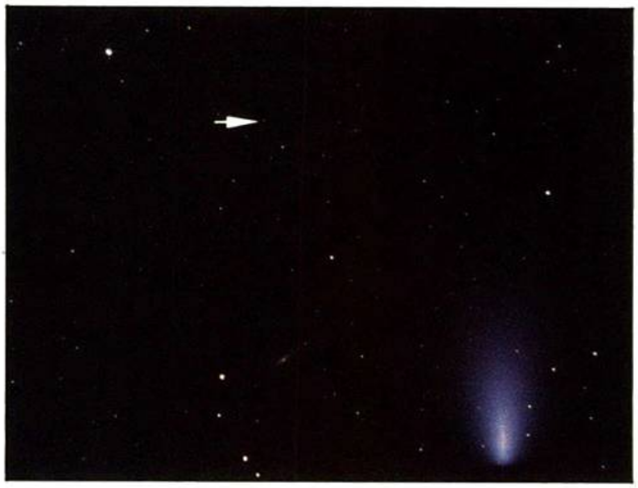
1st: 21h 36m 19s, −10° 26.6′
10th: 21h 36m 07s, −11° 31.1′
20th: 21h 38m 44s, −12° 24.1′



Satellites of Jupiter **3h00m UT**

Jupiter = J, Io = I, Europa = E, Ganymede = G, Callisto = C
(South is at top, matching the view in a telescope)





Left: This pair of photos taken six nights apart shows Pluto (indicated by the arrow) moving between the galaxies NGC-5740 and NGC-5746 in Virgo. Pluto's proximity to the two galaxies — NGC-5746 is the large, edge-on spiral and NGC-5740 the smaller spiral — made locating the 13.8-magnitude speck of light relatively easy for users of large telescopes during the final days of May. The photo at the top was made on May 20, 1987, with a 17.5-inch f/4.5 reflector, 3M 1000 film, and a 9-minute exposure. The photo on the bottom was made with the same equipment, film, and exposure on May 26. Photos by Joe Liddell.

Right: Sheldon Faworski's photograph of the Moon's southern highlands nets this month's $100 "Best Astrophoto" award. Faworski made the photo with a 5-inch achromatic refractor at f/90 and ISO 50 slide film. The prominent small crater just left of center is Aliacensis; to its upper left is similar-sized Werner and to its lower left is the large crater Walter, which has a prominent central peak. The two large craters near the bottom are Stofler (left) and Maurolycis.

30th: 21h 44m 12s, −12° 56.9′

Juno sets around 2 a.m. local daylight time on the 15th.

4 Vesta (8.1) spends nearly all of October moving eastward in Cancer. Its positions:

1st: 7h 54m 24s, 19° 46.1′
10th: 8h 06m 01s, 19° 25.3′
20th: 8h 17m 43s, 19° 04.1′
30th: 8h 27m 54s, 18° 47.0′

Vesta rises around 1 a.m. local daylight time on the 15th.

129 Antigone (12.3) is moving retrograde in the tail region of Cetus and comes to opposition on October 27. Its positions:

1st: 2h 22m 51s, −2° 28.9′
10th: 2h 16m 58s, −3° 25.6′
20th: 2h 09m 32s, −4° 22.7′
30th: 2h 01m 41s, −5° 08.8′

Antigone is visible the entire night.

To locate a minor planet, plot its dated positions (given for 0h UT) lightly in pencil on a good star map (*Sky Atlas 2000.0* or *Uranometria 2000.0*, for example) and sketch a smooth curve linking the points. Then observe the starfield at low magnification and photograph or plot by hand what you see. Check the field a night or two later; the "star" that moved is the minor planet. (All minor planet coordinates are for the epoch 2000.)

Jupiter

Jupiter arrives at its closest and brightest opposition in the past twelve years on October 18. Your telescope will show a disk that measures 49.7″ across the equator and 46.5″ over the poles. (Jupiter's "belly" spreads out because the planet has a low density and spins so fast that the Jovian day lasts only ten hours.)

The two dark stripes across the middle of Jupiter are the north and south equatorial belts. The famed Great Red Spot lies in the white zone just south of the south equatorial belt. (Remember that south is up in an astronomical telescope.) The Red Spot never appears red; rather, it is a dusty brick color at best. But in recent years even the washed-out brick color has faded, and neophytes should instead look for a grayish oval in the light-hued zone.

Many experienced observers use glass or gelatine photofilters over the eyepiece to enhance contrast on Jupiter's disk. If you have one of these filters, give it a try. (Don't bother with a skylight filter, however.) A bluish filter darkens the Red Spot and makes it more prominent. Twilight viewing is also useful because it lessens the dazzling contrast between the bright planet and the sky surrounding it.

October nights are long, and Jupiter can be viewed the entire night. This means that if you observe a feature disappearing around Jupiter's limb in the evening, you'll be able to spy the same feature reappearing on the other side in the hours after midnight. Likewise, a full evening's viewing will show half of Jupiter's features across the disk.

This is a fine opportunity to enjoy viewing the largest planet in the solar system. Don't miss it.

Saturn

This is the last month you can get pretty good views of Saturn before it sinks too low toward the horizon. On the 15th, the ring system spreads 36″ across, and Saturn's equator measures 16″. (Like Jupiter, Saturn spins rapidly and therefore its girth is greater than its polar diameter.)

Saturn also has belted markings like Jupiter, though they are less noticeable because they are intrinsically fainter and partially hidden by haze in Saturn's atmosphere. Try photofilters and twilight viewing to bring them into view.

Uranus

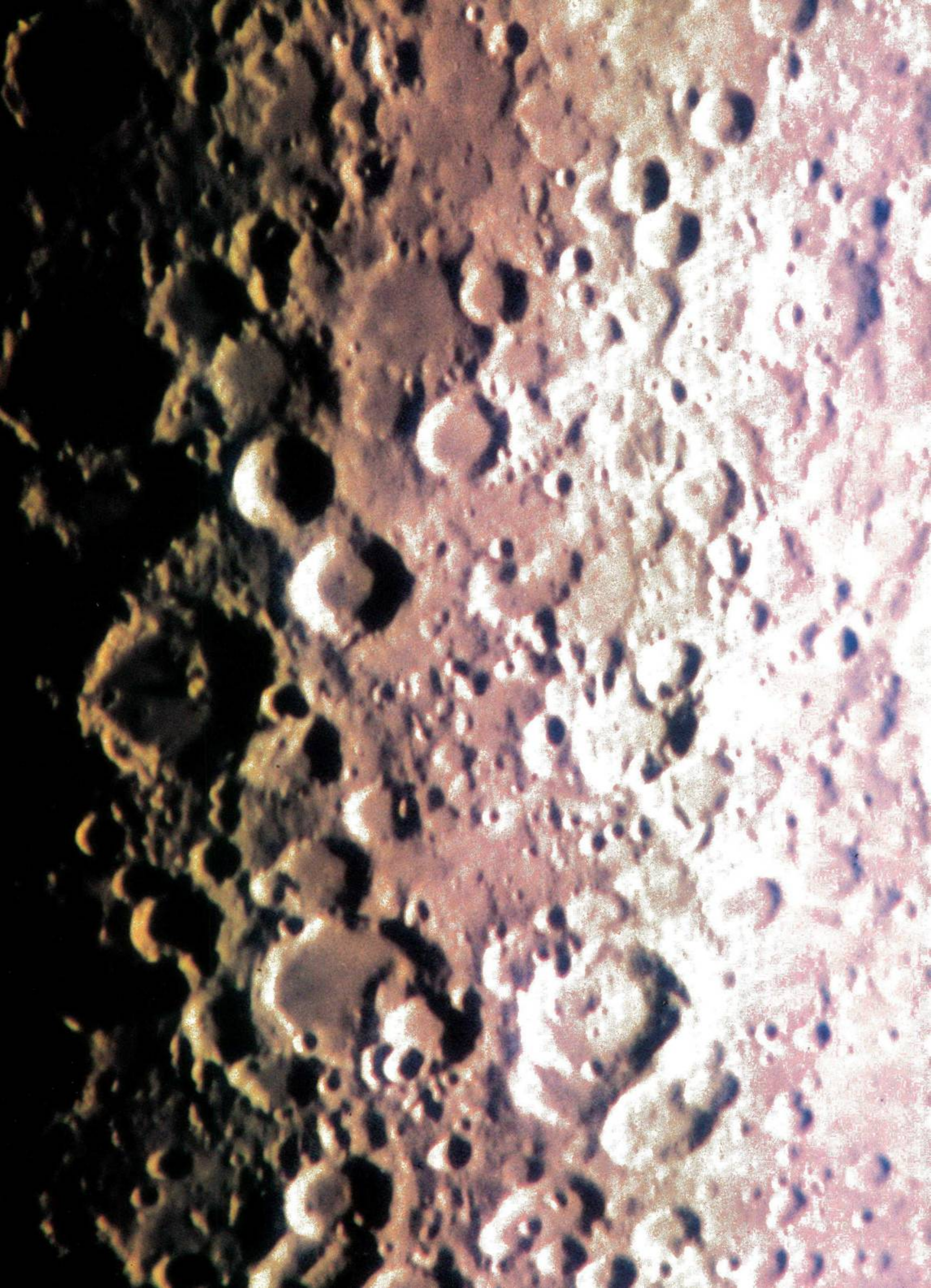
On October 1, Uranus lies almost in a line with the magnitude 3.3 star Theta (θ) Ophiuchi and the magnitude 4.2 star 44 Ophiuchi. Uranus' magnitude is 5.7, and its blue-green disk measures 3.6″ across. Sweep the area with your finder scope and then check with a low-power eyepiece. Uranus' color will catch your eye as much as its clearly nonstellar disk will.

Neptune

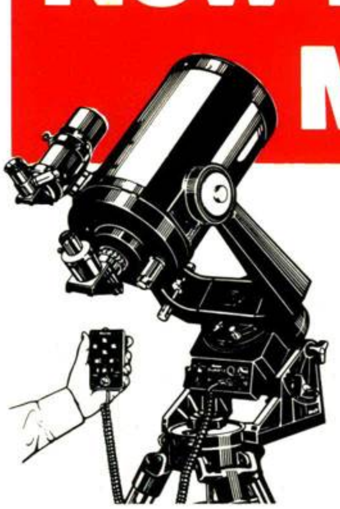
Neptune lies 3° north and about 40′ of right ascension west of the 3rd-magnitude star Lambda (λ) Sagittarii. This region is crowded, and Neptune doesn't have an obvious blue-green color as Uranus does. Therefore, you'll have to examine each candidate object carefully, remembering that Neptune is shining at magnitude 7.9 and measures 2.2″ across. (Finder charts for Uranus and Neptune are in the January 1987 issue on page 108.)

Pluto

During October Pluto is too close to the Sun to be visible.



New from Meade MTS & LX5 Scopes



Meade 2080 LX-5 $1739
The Ultimate 8" Schmidt-Cassegrain! Its impressive list of *standard* features makes the new 2080 LX-5 the ideal telescope for all applications. And the new Meade Multi-Coated Optics Group (MCOG) insures maximum light transmission and image brightness for brilliant viewing and high-contrast photography.

Standard Features:

- AC/DC Quartz/Pulse drive
- Electronic Command Control
- 2x correction speed/8x scanning speed
- 2" diagonal mirror
- 9x60 polar illuminated viewfinder
- Super Plossl 26mm eyepiece
- Adjustable field tripod and wedge
- Lifetime warranty, and much more!

Meade 2120 LX-5 $2595
The Ultimate 10" Schmidt-Cassegrain! For more detailed viewing and astrophotography applications. Includes standard LX-5 accessories and the improved Multi-Coated Optics Group.

Meade LX-5 Accessories

#39 declination motor	$99
Off-axis guider system	$159
Tube balance system	$99
Super Plossl 56mm eyepiece (2")	$179
#1200A electric focuser	$149
8" dew shade	$59
10" dew shade	$99

Meade 2080 LX-3 CALL

Meade 2120 LX-3 CALL

Meade LX-3 Accessories

#36 hand control	$99
#38 declination motor	$99
Both #36 and #38, Only	$189
Widefield adapter system	$129

Meade 2120 GEM with MCSO $1829
10" Schmidt-Cassegrain on rugged German Equatorial Mount. Includes sturdy adjustable metal tripod, polar axis finder, 26mm Super Plossl eyepiece, case, and more.

Special!
All Meade
Series 4000 Eyepieces
40% OFF
suggested retail price!

Meade 2045 LX-3 $779
4" Schmidt-Cassegrain with quartz drive AC/DC operation and state-of-the-art electronics. Includes clock drive, metal-clad case, 5x24mm finder, 40x and 111x eyepieces, coated optics, tabletop tripod, lifetime warranty, and more.

Meade 2045 $579

Accessories for the 2045

4" Dew Shield	$49
#38A Declination motor	$89
Piggyback mount	$19

Meade DS 16A $1849
16" Deep space reflector for serious space viewing and astrophotography. Shipping truck freight collect.

Meade DS 10A $929

Starter Telescopes

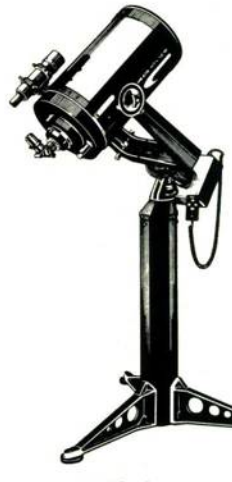
Meade 226 $129
A beginning refractor with professional quality! Features durable metal tube and focuser with 25mm and 9mm eyepieces, star diagonal, adjustable wood tripod, and altazimuth mount.

Meade 277 $149
True rich field telescope yields brilliant images. Perfect for nebulae, galaxies, and other diffuse objects. Includes heavy duty table tripod, 25mm eyepiece, star diagonal, and compact carrying case.

Meade 277 Kit $249
A complete 277, plus porroprism, 9mm eyepiece, camera adapter, and T-mount. Perfect for wildlife!

New! Meade MTS Catadioptrics!
The modular telescope system by Meade offers an inexpensive, yet incredibly flexible telescope for astronomers at every level! Choose from Schmidt-Cassegrain or fast Schmidt-Newtonian designs. Made in USA.

Meade MTS-SC8	**$849**
Meade MTS-SC10	**$1399**
Meade MTS-SN6	**$549**
Meade MTS-SN8	**$849**
With Multi-Coated Optics Group (MCOG)	**add $99**



Meade MTS Accessories

788 Drive System	$149
43 Drive Corrector	$99
790 Drive System with control	$439
66A or 66C Manual Declination Control	$59
38M Declination Motor	$99
109 Setting Circles	$39
Viewfinders	starting at $49

Used Telescopes!

Because of our large volume and exceptional trade-in policy, National Camera Exchange offers a great selection of quality used telescopes. Call or write for a current listing. Choose from Schmidt-Cassegrain, reflector, or refractor types....plus a large selection of used accessories.

Send $2
for the new
National Camera Exchange
Telescope Catalog!

Telescopes

Tele Vue Renaissance Telescope $1295
4" f/5.5 refractor with 4-element multi-coated objective. 5° Rich Field capability and high resolution. Old world craft with modern technology. Comes with one eyepiece. (Choose 7.4mm, 10.5mm, 13mm 17mm, 21mm, or 26mm.)

Tele Vue Oracle 3 Telescope $695
This superb 3" refractor is a razor-sharp spotting scope, telephoto lens, or astronomical telescope. Complete with 2" Star Diagonal, Plossl eyepiece, and case.

Let us help you create your ideal Tele Vue System!

Celestron 20x80 Deluxe binoculars $479
High magnification for astronomical viewing, plus 3.5° wide field. With sturdy slide balance tripod mount.

Celestron C-11 with Starbright $4295
IN STOCK!
Define detail you've never seen before! This portable 11" Schmidt-Cassegrain yields a spectacular image both visually and photographically. Includes 8x50 polar finder, 18mm eyepiece, wedge, tripod, cases, and much more.

Use your
Visa, Master Card, or Discover Card!

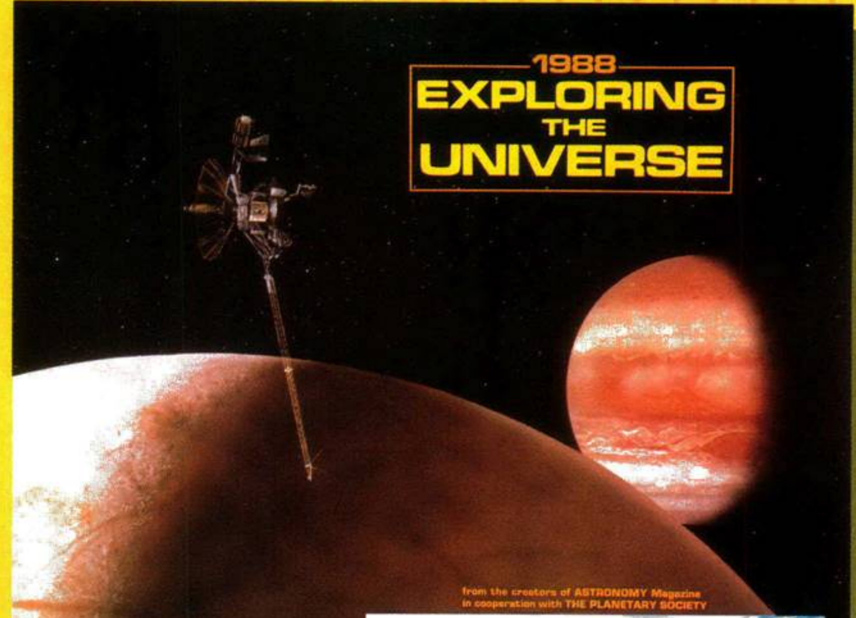
Since 1914
National Camera Exchange
+Video

9300 Olson Memorial Highway, Golden Valley, Minnesota 55427
For information, call the telescope experts:
Brad Daniels, Jeff Marshall, or Dennis Quiggle at **(612) 546-6831.**

TO ORDER CALL TOLL-FREE 1-800-624-8107

Bring the Wonders of Space to Your World!

ASTRONOMY's 1988 EXPLORING THE UNIVERSE calendar takes you from the evolution of Earth to the rich coloration of a mysterious nebula to Olympus Mons – the Solar System's largest volcano – to a remarkable cluster of galaxies in Hercules! More than for daily reference, our exciting calendar brings all the power and beauty of the universe to your wall. 1988 marks the 15th publication of ASTRONOMY's calendar and our anniversary edition features 13 superb 11″ x 14″ color images, fascinating essays for each month, and new for this year, "The Planets This Month", telling you when and where to find the planets throughout the year. Order now!


1988
EXPLORING
THE
UNIVERSE
from the creators of ASTRONOMY Magazine
in cooperation with THE PLANETARY SOCIETY

FEBRUARY

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29					

Gift givers! Buy 3, get a 4th FREE!

- **Full-color printing on heavy gloss stock**
- **Ample space to note appointments and special events**
- **Extra-heavy cover is laminated for durability**
- **Hundreds of celestial events, anniversaries, and holidays listed**

$7.95
#68046

To order, use the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., 1027 N. Seventh St., Milwaukee, WI 53233. Include for postage and handling: U.S. $1; foreign $1.50. Wisconsin residents add 5% sales tax.

Celestron's New Powerstar II.

Powerstar II. Celestron introduces the newest version of the C8, the world's most famous telescope. If there is a leading telescope, this is it; a recent study showed that twice as many serious amateur astronomers consider Celestron the "best overall" 8-inch telescope, over any other brand.

It has been that way for 22 years. This legendary 8-inch Schmidt-Cassegrain has always offered unsurpassed optical excellence, portability and precision.

Today it offers a limited lifetime warranty, Starbright® coatings for unsurpassed contrast and transmission, a powerful, brilliant, 8 x 50 Polaris finderscope and our ultra-precise, world-famous Byer's worm gear clock drive (to help you produce the kind of photographic result you see in the background astrophotograph).

Plus each Powerstar II comes complete with a 286 power, 7mm Orthoscopic and superb 77 power, 26mm Plössl eyepiece, a new foam-fitted carrying case, wedge and ultra-stable tripod.

We've added out-of-this-world precision and convenience to your fingertips: a remarkable, built-in, digital quartz drive corrector. Powerful yet compact, it's coupled to an advanced, highly precise, stepping motor. The dual axis quartz drive is 12 volt and multi-functional. An AC adapter is included and the system works equally well in both hemispheres.

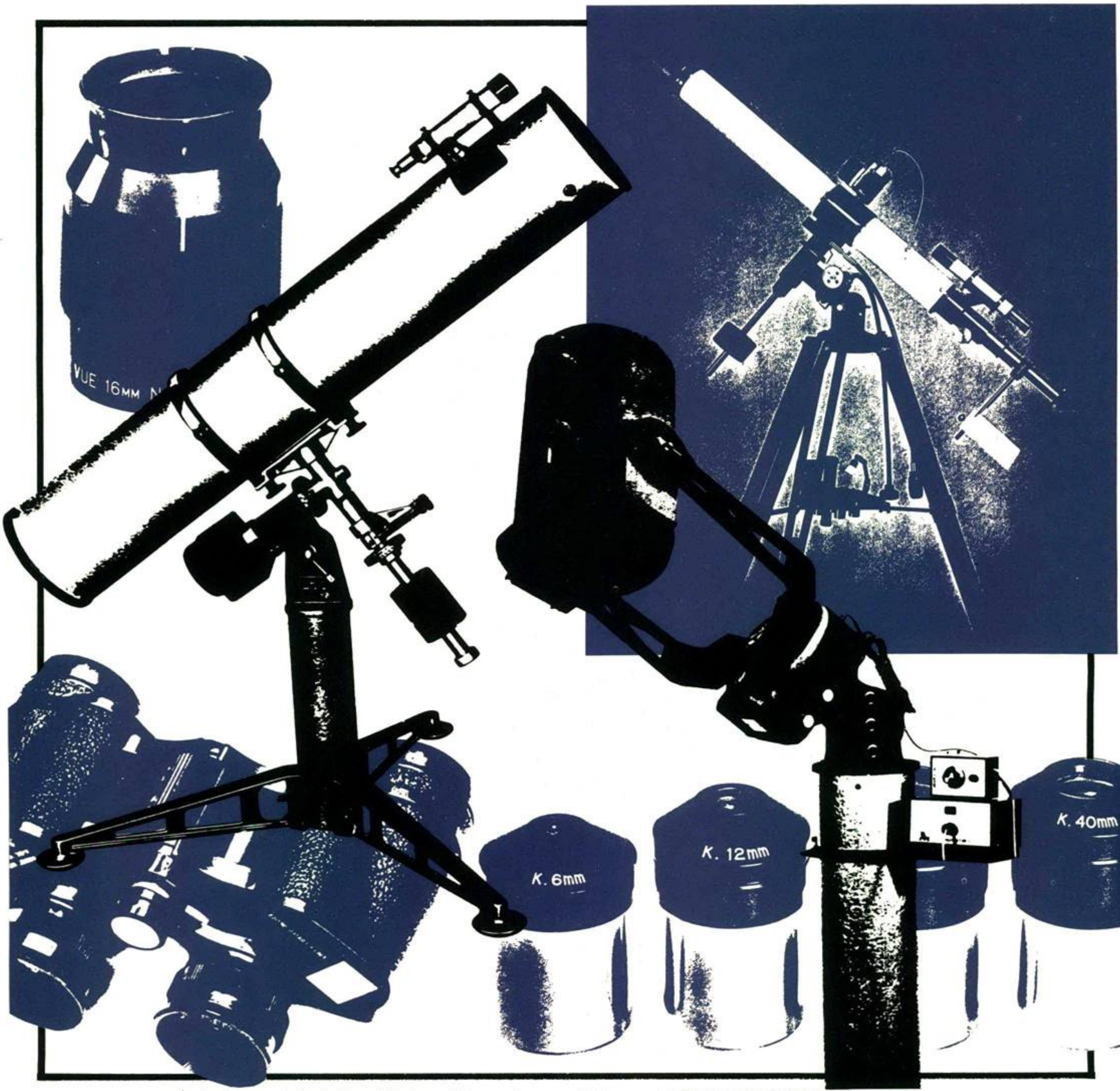
Ask your Celestron Dealer to show you the new Powerstar II. See all the powerful new ways the best...just got better.

CELESTRON®

Celestron International
P.O. Box 3578, 2835 Columbia St., Torrance, CA 90503 (213) 328-9560
For more information and the name of the dealer nearest you,
call Free 1-800-421-1526 (Mon. - Fri. 8 - 4:00 pm, Pacific time in Continental USA only). For a catalog send $3.00 to Celestron International.

ASTRONOMY

Equipment Directory 1987


VUE 16MM N
K. 6mm
K. 12mm
K. 40mm

A Special Advertising Supplement from ASTRONOMY Magazine

Dear Reader:

Once again we bring you our comprehensive annual list of suppliers of astronomy products and services in the form of the *ASTRONOMY Equipment Directory 1987*.

The listings were obtained, in part, from manufacturers, dealers, and related companies that are dedicated to serving the special interest needs of those active in astronomy. This information has been formatted to help you locate suppliers of the products you need to enhance your enjoyment of astronomy and growth in the hobby.

Make good use of the guide — save it, refer to it when making purchase decisions, and mention it to suppliers when contacting them! For your convenience, the directory may be removed by gently pulling it out of the center of the magazine.

If you have any comments on this directory or suggestions for future directories, please let us know.

Best regards,

The ASTRONOMY Advertising Staff

Table of Contents:

Astro-Specialties L
Binoculars .... H
Books/Publications .... K
Cameras .... J
Catadioptric Telescopes .... E
Computers & Software L
Observing Aids I
Photo Accessories .... J
Reflector Telescopes C
Refractor Telescopes C
Telescope Accessories, Components & Services .... F
Travel & Tours .... M

---

*The information in these listings was provided largely by the manufacturers and suppliers. We have done our best to be all-inclusive and regret any omissions or errors.

REFRACTOR TELESCOPES

Ad-Libs Astronomics ad-libs astronomics
Now in our 9th year of saving you money!
2401 Tee Circle
Norman, OK 73069
(405) 364-0858 (800) 422-7876
Retail Dealer, Mail Order Dealer
Celestron, Meade, and TeleVue refractors - all at low discount prices. Now in our 9th year as one of the country's largest full service dealers.

Astro-Physics
7470 Forest Hills Road
Loves Park, IL 61111
(815) 282-1513
Manufacturer

Astronomy Place Astronomy place
2536 N. Beltline Road
Irving, TX 75062
(214) 256-0505
Retail Dealer
Full sales & service. All brands. Scopes & binocs repaired. Southwest's most advanced store. Expert assistance to all levels of amateur astronomers.

Cheshire Custom Optics Co.
Box 65
Mableton, GA 30059
(404) 438-9200
Manufacturer, Mail Order Dealer

Company Seven
Astro-Optics Division
Box 2587
Montpelier, MD 20708-0587
(301) 953-2000
Manufacturer, Retail Dealer, Mail Order Dealer

Dobbins Instrument Company
5168 Lynd Avenue
Lyndhurst, OH 44124
(216) 449-5730
Manufacturer

Edmund Scientific Co.
101 E. Gloucester Pike
Barrington, NJ 08007
(609) 547-3488
Manufacturer, Retail Dealer, Mail Order Dealer

J-ASTRO
20 Argonne Plaza, Box 321
Oakridge, TN 37830
(615) 693-9425
Mail Order Dealer

Martins Star Tracker
3163 Walnut Street
Boulder, CO 80301
(303) 449-3350
Retail Dealer, Mail Order Dealer
Martins Star Tracker has been serving the astronomical community with friendly advice and uncompromising service for nearly ten years. Please call us.

New England Astro-Optics, Inc.
P.O. Box 834
Simsbury, CT 06070
(203) 658-0701
Retail Dealer, Mail Order Dealer
VISA MasterCard
Questar, Meade, Celestron, B&L, TeleVue — export & mail orders — catalog $3.00 — showroom: 2 Gordon Street.

Orion Telescope Center ORION TELESCOPE CENTER
P.O. Box 1158 - 95062
421 Soquel Avenue
Santa Cruz, CA 95062
(408) 458-9090 (800) 447-1001
Retail Dealer, Mail Order Dealer
America's #1 source for telescopes & binoculars. Huge choice, low prices, friendly help, 100% satisfaction guaranteed. Fast delivery, free catalogue.

Pentax
35 Inverness Drive East
Englewood, CO 80112
(303) 799-8000

Seiler Instrument
Planetaria & Telescopes
170 East Kirkham
St. Louis, MO 63119
(314) 968-2282
Manufacturer

Swift Instruments, Inc.
952 Dorchester Avenue
Boston, MA 02125
(617) 436-2960

Tele Vue Optics, Inc. the RENAISSANCE™ Tele Vue
20-A Dexter Plaza
Pearl River, NY 10965
(914) 735-4044
Manufacturer
Patented Plossl,Wide Field,Nagler eyepieces;Adapters,-Barlows,3" apo&4"semi-apo refractors,rich field kits,hi-tech equatorial mounts,astrophotog equip.

T.R. Inc.
P.O. Box 65
Mooers, NY 12958

Underground Camera, Inc.
Burlington Mall
Burlington, MA 01803
(617) 237-2927 (800) 343-1830
Retail Dealer

Unitron Inc. UNITRON
Leisure Products Division
175 Express Street
Plainview, NY 11803
(516) 822-4601
Manufacturer
Unitron refractors, binoculars & spotting scopes offer superb viewing, precision optics and hardware. Contact Unitron for further information.

Vernonscope & Co.
5 Ithaca Road
Candor, NY 13743
(607) 659-7000
Manufacturer

REFLECTOR TELESCOPES

Ad-Libs Astronomics ad-libs astronomics
Now in our 9th year of saving you money!
2401 Tee Circle
Norman, OK 73069
(405) 364-0858 (800) 422-7876
Retail Dealer, Mail Order Dealer
From 4" to 16", all Newtonian and Schmidt-Newtonian reflectors from Meade, Edmund, and Celestron — all discount-priced to save you money.

American Science Center/Jerryco
601 Linden Place
Evanston, IL 60202
(312) 475-8440
Retail Dealer, Mail Order Dealer

Astro World Telescopes
5126 Belair Road
Baltimore, MD 21206
(301) 483-5100
Manufacturer, Retail Dealer, Mail Order Dealer

Astronomy Place
2536 N. Beltline Road
Irving, TX 75062
(214) 256-0505
Retail Dealer
Full sales & service. All brands. Scopes & binocs repaired. Southwest's most advanced store. Expert assistance to all levels of amateur astronomers.

Coulter Optical, Inc.
P.O. Box K
Idyllwild, CA 92349-1107
(714) 659-4621
Manufacturer

Creve Coeur Camera and Video
700 N. New Ballas
St. Louis, MO 63141
(314) 567-3456 (800) 222-8252
Retail Dealer, Mail Order Dealer

Earl Watts Optics
26638 Jamaica Lane
Hayward, CA 94545
(415) 786-2967
Manufacturer, Retail Dealer, Mail Order Dealer

Edmund Scientific Co.
101 E. Gloucester Pike
Barrington, NJ 08007
(609) 547-3488
Manufacturer, Retail Dealer, Mail Order Dealer

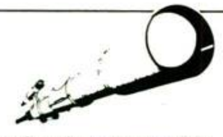
Gluskins Cameras
2110 Pacific Avenue
Stockton, CA 95204
(209) 466-5686
Retail Dealer

Jackson Industries, Inc.
Camera, Video & Optical Division
405 Greenlawn Drive
Columbia, SC 29209
(803) 776-7000
Retail Dealer, Mail Order Dealer

Jena Scientific Instruments, Inc.
820 Second Avenue
New York, NY 10017
(212) 867-3051
Manufacturer

Kurt's Camera Corral Inc.
3417 Central N.E.
Albuquerque, NM 87106
(505) 266-7766
Retail Dealer, Mail Order Dealer

Martins Star Tracker
3163 Walnut Street
Boulder, CO 80301
(303) 449-3350
Retail Dealer, Mail Order Dealer
Martins Star Tracker has been serving the astronomical community with friendly advice and uncompromising service for nearly ten years. Please call us.



Meade Instruments Corporation
1675 Toronto Way
Costa Mesa, CA 92626
(714) 556-2291
Manufacturer
World's leading manufacturer of astronomical telescopes for the serious amateur. 25 models:Schmidt-Cassegrains, Newtonians, Refractors. $200 - $5000.

Meade®
THE LEADER'S EDGE

Morvac Optical Coating
2300 Walnut - #B
Signal Hill, CA 90806
(213) 424-2062
Manufacturer

New England Astro-Optics, Inc.
P.O. Box 834
Simsbury, CT 06070
(203) 658-0701
Retail Dealer, Mail Order Dealer
Questar, Meade, Celestron, B&L, TeleVue — export & mail orders — catalog $3.00 — showroom: 2 Gordon Street.

Orion Telescope Center
P.O. Box 1158 - 95062
421 Soquel Avenue
Santa Cruz, CA 95062
(408) 458-9090 (800) 447-1001
Retail Dealer, Mail Order Dealer
America's #1 source for telescopes & binoculars. Huge choice, low prices, friendly help, 100% satisfaction guaranteed. Fast delivery, free catalogue.

Perfecta Camera Corp.
116 West Broadway
Derry, NH 03038
(603) 432-9600
Retail Dealer, Mail Order Dealer

Perfecta Camera Corp.
885 Second Street
Manchester, NH 03102
(603) 627-4482
Retail Dealer, Mail Order Dealer

Quasar Optics Inc.
7220A Fairmont Drive, S.E.
Calgary, ALB T2H 0X7 Canada
(403) 255-7633
Manufacturer, Retail Dealer, Mail Order Dealer

R.V.R. Optical
P.O. Box 62
Eastchester, NY 10709
(914) 337-4085
Manufacturer, Retail Dealer, Mail Order Dealer

Renown Optical Inc.
Precision Optics
17893 Bennett Road
Cleveland, OH 44133
(216) 237-9114
Manufacturer

Roger W. Tuthill Inc.
11 Tanglewood Lane
Mountainside, NJ 07092
(201) 232-1786 (800) 223-1063
Manufacturer, Retail Dealer, Mail Order Dealer
QUARTZ CORDLESS Scopes, SOLAR SKREEN® SUN FILTERS, Heated NO Du Caps, Instructional Video Tapes, Finders, LOW Cost Plossls, Digital Readouts.

Science Magic, Inc.
Div. of Edmonton Space Sciences Center
11211-142 Street
Edmonton, ALB Canada
(403) 451-6516
Retail Dealer, Mail Order Dealer

Sky Designs
6108 Hunter Lane
Colleyville, TX 76034
(817) 656-4326
Manufacturer, Mail Order Dealer

Sky Optical
12428 Gladstone
Sylmar, CA 91342
(818) 361-6576
Manufacturer

Star-Liner Co.
1106 S. Columbus
Tucson, AZ 85711
(602) 795-3361

TBR Associates Inc.
850 Hudson Avenue
Rochester, NY 14621
(716) 544-2162
Mail Order Dealer

Telescopics
P.O. Box 98
La Canada, CA 91011
(818) 341-8178
Manufacturer

Valley Telescope Ltd.
Reflector Telescopes
17848 Varene Court
Linden, CA 95236
(209) 887-2106
Manufacturer

CATADIOPTRIC TELESCOPES

Ad-Libs Astronomics ad-libs astronomics Now in our 9th year of saving you money!
2401 Tee Circle
Norman, OK 73069
(405) 364-0858 (800) 422-7876
Retail Dealer, Mail Order Dealer
The cream of the crop - from Meade, Celestron, Questar, Bauch and Lomb - priced to save you money. Our 9th year as a full service telescope dealer.

Adler Planetarium
The Planetarium Store
1300 South Shore Drive
Chicago, IL 60605
(312) 322-0304
Retail Dealer

Astronomy Place Astronomy place
2536 N. Beltline Road
Irving, TX 75062
(214) 256-0505
Retail Dealer
Full sales & service. All brands. Scopes & binocs repaired. Southwest's most advanced store. Expert assistance to all levels of amateur astronomers.

Bausch & Lomb BAUSCH & LOMB
Criterion Division
135 Prestige Park Circle
East Hartford, CT 06108
(203) 282-0768
Manufacturer
The world's finest optics, manufactured and backed by a 133 year old company. For information please call.

Camera Center Inc.
1533 Wealthy St. SE
Grand Rapids, MI 49506
(616) 458-7703
Retail Dealer

Celestron International CELESTRON
2835 Columbia Street
Torrance, CA 90503
(213) 328-9560 (800) 421-1526
Manufacturer
8",11",14" Schmidt Cassegrains; reflectors,refractors,-giant binocs including 25x125; full line of accessories. Limited lifetime warranty.

Coke's Camera Center
Astronomy
735 Cherry Street
Macon, GA 31213
(912) 746-3286
Retail Dealer, Mail Order Dealer

Cosmic Connections, Inc.
1460 N. Farnsworth Avenue
Aurora, IL 60505
(312) 851-5353 (800) 247-9705
Retail Dealer, Mail Order Dealer

Douglas Telescopics
531 State
Santa Barbara, CA 93101
(805) 966-2888
Retail Dealer

Edelman's Edelman's
Telescope & Binoculars Division
465 Route 46 West
Wayne, NJ 07470
(201) 227-2515
Retail Dealer, Mail Order Dealer
Scopes-Celestron,Meade,B&L/Bushnell,TeleVue; binocular/spotters-Zeiss,Leitz,Bushnell,Steiner, Swarovski,Celestron,Pentax,Nikon; Fred will help you.

Edmund Scientific Co.
101 E. Gloucester Pike
Barrington, NJ 08007
(609) 547-3488
Manufacturer, Retail Dealer, Mail Order Dealer

Eftonscience, Inc.
3350 Dufferin Street
Toronto, ONT M6A 3A4 Canada
(416) 787-4581
Retail Dealer, Mail Order Dealer

Energy Sciences, Inc.
11703L Fair Oaks Mall
Fairfax, VA 22033
(703) 385-5773
Retail Dealer, Mail Order Dealer

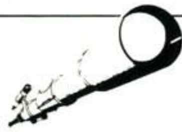
F.C. Meichsner Co.
182 Lincoln Street
Boston, MA 02111
(617) 426-7092
Retail Dealer, Mail Order Dealer

Fishkin Bros. Inc.
285 Madison Avenue
Perth Amboy, NJ 08861-4395
(201) 826-0048
Retail Dealer

Focus Camera Inc.
4419-21 13th Avenue
Brooklyn, NY 11219
(718) 436-6262 (800) 221-0828
Retail Dealer, Mail Order Dealer

France Photo
1330 Willamette Street
Eugene, OR 97401
(503) 343-2816
Retail Dealer

Martins Star Tracker
3163 Walnut Street
Boulder, CO 80301
(303) 449-3350
Retail Dealer, Mail Order Dealer
Martins Star Tracker has been serving the astronomical community with friendly advice and uncompromising service for nearly ten years. Please call us.



Meade Instruments Corporation Meade® THE LEADER'S EDGE
1675 Toronto Way
Costa Mesa, CA 92626
(714) 556-2291
Manufacturer
World's leading manufacturer of astronomical telescopes for the serious amateur. 25 models:Schmidt-Cassegrains, Newtonians, Refractors. $200 - $5000.

Merrill Photo Supply Co. Inc.
233 Hale Street
Charleston, WV 25301
(304) 343-0141
Retail Dealer

Nelson Photo Supplies
P.O. Box 85127
San Diego, CA 92138
(619) 234-6621
Retail Dealer

New England Astro-Optics, Inc.
P.O. Box 834
Simsbury, CT 06070
(203) 658-0701
Retail Dealer, Mail Order Dealer
Questar, Meade, Celestron, B&L, Televue — export & mail orders — catalog $3.00 — showroom: 2 Gordon Street.

Orion Telescope Center
P.O. Box 1158 - 95062
421 Soquel Avenue
Santa Cruz, CA 95062
(408) 458-9090 (800) 447-1001
Retail Dealer, Mail Order Dealer
America's #1 source for telescopes & binoculars. Huge choice, low prices, friendly help, 100% satisfaction guaranteed. Fast delivery, free catalogue.

Perceptor
Brownsville Junction Box 39
Schomberg, ONT L0G 1T0 Canada
(416) 939-2313
Retail Dealer, Mail Order Dealer

Questar Corporation
P.O. Box 59
New Hope, PA 18938
(215) 862-5277
Manufacturer, Retail Dealer, Mail Order Dealer

Rainbow Camera Inc.
802 Fort Street Mall
Honolulu, HI 96813
(808) 531-4618
Retail Dealer, Mail Order Dealer

Rivers Camera Shop
454 Central Avenue
Dover, NH 03820
(603) 742-4888
Retail Dealer

Roger W. Tuthill Inc.
11 Tanglewood Lane
Mountainside, NJ 07092
(201) 232-1786 (800) 223-1063
Manufacturer, Retail Dealer, Mail Order Dealer
QUARTZ CORDLESS Scopes, SOLAR SKREEN® SUN FILTERS, Heated NO Du Caps, Instructional Video Tapes, Finders, LOW Cost Plossls, Digital Readouts.

S & S Optika, Ltd.
5172 South Broadway
Englewood, CO 80110
(303) 789-1089
Retail Dealer

Science Education Center
125 South Hillside
Wichita, KS 67211
(316) 682-1921
Retail Dealer, Mail Order Dealer

Scope City Canada Ltd.
247 Marlee Avenue, Unit 201
Toronto, ONT M6B 4B8 Canada
(416) 783-4140
Retail Dealer, Mail Order Dealer

Star Quest Enterprise
Telescopes
378 S. Tustin Avenue
Orange, CA 92666
(714) 633-8505
Retail Dealer

TBR Associates Inc.
850 Hudson Avenue
Rochester, NY 14621
(716) 544-2162
Mail Order Dealer

The Nature Center
11743 Fair Oaks Boulevard
Fair Oaks, CA 95628
(916) 967-5781
Retail Dealer, Mail Order Dealer

The Stangert Corp.
240 Long Beach Road
Island Park, NY 11558
(516) 432-4277
Retail Dealer, Mail Order Dealer

Wolfe's Camera & Video
Telescope Center
635 Kansas Avenue
Topeka, KS 66603
(913) 235-1386
Retail Dealer, Mail Order Dealer

TELESCOPE ACCESSORIES, COMPONENTS & SERVICES

AB Machining
5734 Industrial Road
Fort Wayne, IN 46825
(219) 483-1418
Manufacturer

Ad-Libs Astronomics
2401 Tee Circle
Norman, OK 73069
(405) 364-0858 (800) 422-7876
Retail Dealer, Mail Order Dealer
Parts and accessories from Meade, Celestron, Edmund, TeleVue, Lumicon, Daystar, Telrad, Motofocus, University Optics, Bausch and Lomb and many others.

Now in our 9th year of saving you money!

Advanced Technology Instruments
Computer Aided Telescope (CAT) Division
P.O. Box 246
Carmel Valley, CA 93924
(408) 659-0437
Manufacturer, Retail Dealer, Mail Order Dealer

Ash Manufacturing Company, Inc.
Box 312
Plainfield, IL 60544
(815) 436-9403
Manufacturer

Astro-Computer Control
Road #1
Alexandria, PA 16611
(814) 669-4483
Manufacturer

Astro-Tech
101 West Main- P.O. Box 2001
Ardmore, OK 73402
(405) 226-3074
Manufacturer, Retail Dealer, Mail Order Dealer

Astronomy Place
2536 N. Beltline Road
Irving, TX 75062
(214) 256-0505
Retail Dealer
Full sales & service. All brands. Scopes & binocs repaired. Southwest's most advanced store. Expert assistance to all levels of amateur astronomers.

Augen Optics
947 Parkside Lane
Lancaster, PA 17601
(717) 295-4679
Manufacturer

Bob's Electronic Service
7605 Deland Avenue
Ft. Pierce, FL 33451
(305) 464-2118

Chicago Optical & Supply Co.
Box 1361
Morton Grove, IL 60053
(312) 827-4846
Mail Order Dealer

David Harbour & Associates
"The Mirror Doctor"
2321 C Court, P.O. Box 6081
Enid, OK 73702-6081
(405) 237-4034

Davionx
3535 Shafer Drive
Santa Clara, CA 95051
(408) 244-4660
Manufacturer, Mail Order Dealer

DayStar Filters
P.O. Box 1290
Pomona, CA 91769
(714) 591-4673
Manufacturer

Edwin Hirsch
168 Lakeview Drive
Tomkins Cove, NY 10986
(914) 786-3738
Mail Order Dealer

Edward R. Byers Co.
29001 West Highway 58
Barstow, CA 92311
(619) 256-2377
Manufacturer, Retail Dealer, Mail Order Dealer

Electrophysics Corporation
48 Spruce Street
Nutley, NJ 07110
(201) 667-2262
Manufacturer

Evaporated Metal Films
701 Spencer Road
Ithaca, NY 14850
(607) 272-3320

E&W Optical, Inc.
2420 East Hennepin Avenue
Minneapolis, MN 55413
(612) 331-1187
Manufacturer

F.C. Meichsner Co.
182 Lincoln Street
Boston, MA 02111
(617) 426-7092
Retail Dealer, Mail Order Dealer

Galaxy Optics
231 S. Madison Avenue
Louisville, CO 80027
Manufacturer

Howard Engineering
2088 East Central Avenue
Duarte, CA 91010
(818) 359-8819
Manufacturer, Retail Dealer

Jim's Mobile Industries
1960 County Road 23
Evergreen, CO 80439
(303) 277-0304
Manufacturer

Kenneth Novak & Co.
Box 69
Ladysmith, WI 54848
(715) 532-5102
Manufacturer, Retail Dealer, Mail Order Dealer

Lumicon
Filters & Astrophotography Division
2111 Research Drive, Suites 5-6
Livermore, CA 94550
(415) 447-9570
Manufacturer, Retail Dealer, Mail Order Dealer

Martins Star Tracker
3163 Walnut Street
Boulder, CO 80301
(303) 449-3350
Retail Dealer, Mail Order Dealer
Martins Star Tracker has been serving the astronomical community with friendly advice and uncompromising service for nearly ten years. Please call us.

Meade Instruments Corporation
1675 Toronto Way
Costa Mesa, CA 92626
(714) 556-2291
Manufacturer

Metro Machining
2641 44th Street North
St. Petersburg, FL 33713
(813) 527-1040
Manufacturer

National Camera Exchange
9300 Olson Highway
Golden Valley, MN 55427
(612) 546-6831 (800) 624-8107
Retail Dealer, Mail Order Dealer

New England Astro-Optics, Inc.
P.O. Box 834
Simsbury, CT 06070
(203) 658-0701
Retail Dealer, Mail Order Dealer
VISA MasterCard
Questar, Meade, Celestron, B&L, TeleVue — export & mail orders — catalog $3.00 — showroom: 2 Gordon Street.

Observa-Dome Laboratories, Inc.
371 Commerce Park Drive
Jackson, MS 39213
(601) 982-3333
Manufacturer

Optomechanics Research, Inc.
Dr. Ron Hillard
P.O. Box 36522
Tucson, AZ 85740
(602) 887-4304
Manufacturer

Orion Telescope Center
ORION TELESCOPE CENTER
P.O. Box 1158 - 95062
421 Soquel Avenue
Santa Cruz, CA 95062
(408) 458-9090 (800) 447-1001
Retail Dealer, Mail Order Dealer
America's #1 source for telescopes & binoculars. Huge choice, low prices, friendly help, 100% satisfaction guaranteed. Fast delivery, free catalogue.

P. A. Clausing
8038 Monticello Avenue
Skokie, IL 60076
(312) 267-3399

Pauli's Discount Optics
29 Kingswood Road
Danbury, CT 06811
(203) 746-3579
Retail Dealer, Mail Order Dealer

Photo Supply
De Vargas Mall
Santa Fe, NM 87501
(505) 982-2585
Retail Dealer, Mail Order Dealer

Roger W. Tuthill Inc.
CELESTRON
Authorized Meade Dealer
11 Tanglewood Lane
Mountainside, NJ 07092
(201) 232-1786 (800) 223-1063
Manufacturer, Retail Dealer, Mail Order Dealer
QUARTZ CORDLESS Scopes, SOLAR SKREEN® SUN FILTERS, Heated NO Du Caps, Instructional Video Tapes, Finders, LOW Cost Plossls, Digital Readouts.

Ruby Optics
21 Balaclava Street
Kingston, ON K7K 1J4
(613) 544-5857
Manufacturer

S & S Optika, Ltd.
S&S OPTIKA
5172 South Broadway
Englewood, CO 80110
(303) 789-1089
Retail Dealer
Specializing in only the finest equipment - Clave', Tele-Vue, Takashi, Leitz, Pentax, Celestron, Annual Moon Calendar, and more.

Spectrum
P.O. Box 32188
Phoenix, AZ 85016
(602) 955-6773
Manufacturer, Retail Dealer, Mail Order Dealer

Steve Kufeld
7092 Betty Drive
Huntington Beach, CA 92647
(714) 847-8903
Manufacturer, Mail Order Dealer

Sunwest Space Systems, Inc.
P.O. Box 20500
St. Petersburg, FL 33742-0500
(813) 577-0629
Manufacturer

Tele Vue Optics, Inc.
the Renaissance™
Tele Vue
20-A Dexter Plaza
Pearl River, NY 10965
(914) 735-4044
Manufacturer
Patented Plossl,Wide Field,Nagler eyepieces;Adapters,-Barlows,3'' apo&4''semi-apo refractors,rich field kits,hi-tech equatorial mounts,astrophotog equip.

The Image Point
831 N. Swan
Tuscon, AZ 85711
(602) 327-6643
Manufacturer

University Optics Inc.
P.O. Box 1205
Ann Arbor, MI 48106
(800) 521-2828
Manufacturer

Van Reenen Tool & Die, Inc.
70 Holworthy Street
Rochester, NY 14606
(716) 328-0371
Manufacturer

Vogel Enterprises, Inc.
VE Digitrak
P.O. Box 3717
Oak Park, IL 60303
(312) 456-TRAK (800) 457-TRAK
Manufacturer, Mail Order Dealer

When contacting suppliers — don't forget to mention that you saw their listing in the *ASTRONOMY Equipment Directory*!

BINOCULARS

Ad-Libs Astronomics
ad-libs astronomics
Now in our 9th year of saving you money!
2401 Tee Circle
Norman, OK 73069
(405) 364-0858 (800) 422-7876
Retail Dealer, Mail Order Dealer
The best binoculars and spotting scopes from Bausch and Lomb, Bushnell, Swarovski, Meade, Celestron and more - all discount-priced to save you money.

Adorama Camera Inc.
42 West 18th Street
New York, NY 10001
(212) 741-0401 (800) 223-2500
Retail Dealer, Mail Order Dealer

Bushnell
300 N. Lone Hill Avenue
San Dimas, CA 91773
(714) 592-8000

Celestial Innovations
HCR Box 3228
Oracle, AZ 85623
(602) 896-9109
Mail Order Dealer

Celestron International
2835 Columbia Street
Torrance, CA 90503
(213) 328-9560 (800) 421-1526
Manufacturer

Dot Dotson's Inc.
P.O. Box 10606
Eugene, OR 97440
(503) 687-8175
Retail Dealer

E. Leitz, Inc.
Photographic Division
24 Link Drive
Rockleigh, NJ 07647
(201) 767-1100
Manufacturer

Esman's
560 Broadway
Pitcairn, PA 15140
(800) 245-2952
Retail Dealer, Mail Order Dealer

Europtik, Ltd.
Sport Optics
P.O. Box 319
Dunmore, PA 18509
(717) 347-6049
Manufacturer

F.C. Meichsner Co.
182 Lincoln Street
Boston, MA 02111
(617) 426-7092
Retail Dealer, Mail Order Dealer

Fujinon Inc.
10 High Point Drive
Wayne, NJ 07470
(201) 633-5600
Manufacturer

Jason Empire, Inc.
P.O. Box 14930
9200 Cody
Overland Park, KS 66214
(913) 888-0220 (800) 255-6366
Manufacturer

Martins Star Tracker
3163 Walnut Street
Boulder, CO 80301
(303) 449-3350
Retail Dealer, Mail Order Dealer
Martins Star Tracker has been serving the astronomical community with friendly advice and uncompromising service for nearly ten years. Please call us.

Milwaukee Rubber Design
3426 Ridge Drive
Hartland, WI 53029
(414) 521-8056
Manufacturer

New England Astro-Optics, Inc.
P.O. Box 834
Simsbury, CT 06070
(203) 658-0701
Retail Dealer, Mail Order Dealer
Questar, Meade, Celestron, B&L, TeleVue — export & mail orders — catalog $3.00 — showroom: 2 Gordon Street.

Nikon Inc.
623 Stewart Avenue
Garden City, NY 11530
(516) 222-0200
Manufacturer
7x50SP Prostar free of coma and color fringing;20x60ED spotting scope with extra low dispersion glass; 10x70II Astroluxe high-powered, sharp & bright.

Nikon SPORT OPTICS
The Legend Continues

Orion Telescope Center
P.O. Box 1158 - 95062
421 Soquel Avenue
Santa Cruz, CA 95062
(408) 458-9090 (800) 447-1001
Retail Dealer, Mail Order Dealer
America's #1 source for telescopes & binoculars. Huge choice, low prices, friendly help, 100% satisfaction guaranteed. Fast delivery, free catalogue.

Paul's Photo Inc.
23845 S. Hawthorne
Torrance, CA 90505
(213) 375-7014
Retail Dealer

Redlich Binocular & Optical Repair Service
2319 Wilson Boulevard
Arlington, VA 22201
(703) 527-5151
Retail Dealer Mail Order Dealer

Sporting Optics, Inc.
Danley's
P.O. Box 1 AY
Ft. Johnson, NY 12070
(518) 842-7853
Mail Order Dealer

Swarovski America, Ltd.
Optik Division
1 Kenney Drive
Cranston, RI 02920-8381
(401) 463-6400 (800) 556-6478
Manufacturer

The Telescope Exchange
4347 Sepulveda Boulevard
Culver City, CA 90230
(213) 397-0871
Retail Dealer

Zeiss Optical, Inc.
Sports Optics
1015 Commerce Street
Petersburg, VA 23803
(804) 861-0033 (800) 446-1807
Manufacturer

OBSERVING AIDS

A Great Shop
Sandpiper Square
Cannon Beach, OR 97110
(503) 436-1129
Retail Dealer

Astro Cards
P.O. Box 35
Natrona Heights, PA 15065
(412) 295-4128
Mail Order Dealer

Astro Link
P.O. Box 1978
Spring Valley, CA 92077
(619) 698-9174
Manufacturer, Mail Order Dealer

Astronomical Society of the Pacific
1290 24th Avenue
San Francisco, CA 94122
(415) 661-8660

F. Klein Publications
515 Magdalena Avenue
Los Altos, CA 94022
Manufacturer, Mail Order Dealer

J&M Enterprises
6420 Balcom Street
Reseda, CA 91335
Mail Order Dealer

Lumicon
Filters & Astrophotography Division
2111 Research Drive, Suites 5-6
Livermore, CA 94550
(415) 447-9570
Manufacturer, Retail Dealer, Mail Order Dealer

Martins Star Tracker
3163 Walnut Street
Boulder, CO 80301
(303) 449-3350
Retail Dealer, Mail Order Dealer
Martins Star Tracker has been serving the astronomical community with friendly advice and uncompromising service for nearly ten years. Please call us.

NightStar Company
1334 Brommer Street
Santa Cruz, CA 95062
(408) 462-1049
Manufacturer, Mail Order Dealer

Optec, Inc.
199 Smith Street
Lowell, MI 49331
(616) 897-9351
Manufacturer

Optical Data
66 Hanover Road
P.O. Box 97
Florham Park, NJ 07932
(201) 377-0302 (800) 524-2481
Retail Dealer

Rigel Systems
28006 Ridgebrook
Rancho Palos Verdes, CA 90274
(213) 544-6574
Manufacturer

Rose Star Products
2913 Teague Drive
Tyler, TX 75701
(214) 592-5218
Manufacturer, Mail Order Dealer
Astrogoggles: dark-adaptation goggle. A red lens lets only red light reach the eye. This sets and preserves night vision. $19.95 + $1.50 check/money order.

Star Explorer
8339 Terrace Drive
El Cerrito, CA 94750
(415) 526-2941
Manufacturer, Retail Dealer, Mail Order Dealer

Tele-Optics, Inc.
P.O. Box #176
Gilberts, IL 60136
(312) 426-7444 (800) VIEWING
Manufacturer, Retail Dealer, Mail Order Dealer

Tersch Enterprises
P.O. Box 1059
Colorado Springs, CO 80901
(303) 597-3603
Manufacturer, Mail Order Dealer

The Observer's Guide
P.O. Box 35
Natrona Heights, PA 15065
(412) 295-4128

Thousand Oaks Optical
Solar Filters
Box 248098
Farmington, MI 48024
(313) 353-6825
Manufacturer

CAMERAS

Ewald-Clark, Inc.
Complete Photographic Centers
17 West Church Avenue
Roanoke, VA 24011
(703) 342-1829
Retail Dealer

Executive Photo & Supply Corp.
120 West 31st Street
New York, NY 10001
(212) 947-5290 (800) 223-7323
Retail Dealer, Mail Order Dealer

Great National Camera Machine, Inc.
1650 North Military Trail
West Palm Beach, FL 33409
(305) 689-3155 (800) 9-CAMERA
Retail Dealer, Mail Order Dealer

Harmon Photo & Video
14330 S. Tamiami Trail
Fort Myers, FL 33912
(813) 482-7220
Retail Dealer

Olympus Corporation
Consumer Products Group
Crossways Park
Woodbury, NY 11797
(516) 364-3000 (800) 433-0880
Manufacturer

Sarasota Camera Exchange & Video
1121 South Tamiami Trail
Sarasota, FL 34237
(813) 366-7484
Retail Dealer, Mail Order Dealer

Severance Photo Inc.
170 Court Street
P.O. Box 539
Watertown, NY 13601
(315) 788-3870
Retail Dealer, Mail Order Dealer

Shutan Camera & Video
312 West Randolph Street
Chicago, IL 60606
(312) 332-2000 (800) 621-2248
Retail Dealer, Mail Order Dealer

Sky Scientific
P.O. Box 184
Skyforest, CA 92385
(714) 337-3440
Manufacturer

Tallahassee Camera Center, Inc.
2880 Apalachee Parkway
Tallahassee, FL 32301
(904) 877-1152
Retail Dealer

Tony Rose Camera
5666 Calle Real
Goleta, CA 93117
(805) 967-5621
Retail Dealer

PHOTO ACCESSORIES

AIC International Inc.
Soligor, USA
168 Glen Cove Road
Carle Place, NY 11514
(516) 742-7300
Manufacturer

Astro Kits
824 Bronx River Rd.
Bronxville, NY 10708
(914) 776-1931
Manufacturer

Evert Achterberg
Purus-Astro-Mechanik Clockwork Rotation Mechanism
P.O. Box 123
Escalon, CA 95320
(209) 838-1259
Mail Order Dealer

HP Marketing Corp.
Rollei
216 Little Falls Road
Cedar Grove, NJ 07009
(201) 857-0171
Manufacturer

J-ASTRO
20 Argonne Plaza, Box 321
Oakridge, TN 37830
(615) 693-9425
Mail Order Dealer

Ken-Mar Camera
27 Great Neck Road
Great Neck, NY 11021
(516) 482-1025
Retail Dealer, Mail Order Dealer

Konica U.S.A., Inc.
Color Print Film 3200 ISO
440 Sylvan Avenue
Englewood Cliffs, NJ 07632
(201) 568-3100
Manufacturer

Lumicon
Filters & Astrophotography Division
2111 Research Drive, Suites 5-6
Livermore, CA 94550
(415) 447-9570
Manufacturer, Retail Dealer, Mail Order Dealer

Martins Star Tracker
3163 Walnut Street
Boulder, CO 80301
(303) 449-3350
Retail Dealer, Mail Order Dealer
Martins Star Tracker has been serving the astronomical community with friendly advice and uncompromising service for nearly ten years. Please call us.

Robert Waxman, Inc.
913 15th Street
Denver, CO 80202
(303) 623-1155
Manufacturer, Retail Dealer, Mail Order Dealer

Spectra Astro-Accessories
SureSharp Astrophoto Focus Aid
8726-D South Sepulveda Blvd., Ste. 441
Los Angeles, CA 90045
(213) 649-3842
Manufacturer, Mail Order Dealer

Tau Ceti
Camera Adapters
P.O. Box 1101
Conroe, TX 77305
(409) 539-4073
Manufacturer

BOOKS/PUBLICATIONS

Astronomy Book Club
Riverside, NJ 08075
Mail Order Dealer

Basil Blackwell, Inc.
432 Park Avenue South, Suite 1503
New York, NY 10016
(212) 684-2890 (800) 638-3030
Publisher, Mail Order Dealer

Crown Publishers, Inc.
34 Engelhard Avenue
Avenel, NJ 07001
Publisher

Cygnus-Quasar Books
P.O. Box 85
Powell, OH 43065
(614) 548-7895
Publisher

Everything in the Universe
5248 Lawton Avenue
Oakland, CA 94618
(415) 547-6523
Publisher, Retail Dealer, Mail Order Dealer

G. B. Mansek, Inc.
35 S. Main Street, Box 961
Hanover, NH 03755
(603) 2227
Mail Order Dealer

Herbert A. Luft
P.O. Box 91
Oakland Gardens, NY 11364
Mail Order Dealer

Interstellar Media
2153 Russell Street
Berkeley, CA 94705
(415) 848-1989
Publisher

Intrinsic Publishing
Post Office Box 1137
Pikeville, KY 41501
Publisher

John Wiley & Sons
605 Third Avenue
New York, NY 10158-0012
Publisher

Macmillan Publishing Company
866 Third Avenue
New York, NY 10022
(609) 461-6500
Publisher

Martins Star Tracker
3163 Walnut Street
Boulder, CO 80301
(303) 449-3350
Retail Dealer, Mail Order Dealer
Martins Star Tracker has been serving the astronomical community with friendly advice and uncompromising service for nearly ten years. Please call us.

McDonald Observatory
Star Date
UT Austin, TLM 15.308
Austin, TX 78712
(512) 471-5285
Publisher

National Space Society
Space Shop Catalog Division
922 Pennsylvania Avenue, S.E.
Washington, DC 20003
(202) 543-1900
Mail Order Dealer

Springer-Verlag New York, Inc.
175 Fifth Avenue
New York, NY 10010
(212) 460-1500 (800) 526-7254
Publisher, Mail Order Dealer

Sunstone
RD 3, Box 100A
Cooperstown, NY 13326
(607) 547-8207
Publisher, Mail Order Dealer

The Astro-Trader
Classified Shopper
P.O. Box 155
Casa Grande, AZ 85222
(602) 836-6890
Publisher

The Planetary Society
65 N. Carolina Avenue
Pasadena, CA 91106
Publisher, Mail Order Dealer

The Starry Messenger
P.O. Box 4823-E
Ithaca, NY 14852
(607) 277-3621
Publisher

Time-Life Books, Inc.
Richmond, VA 23261
Publisher, Mail Order Dealer

Univelt Inc.
P.O. Box 28130
San Diego, CA 92128
(619) 746-4005
Publisher, Mail Order Dealer

Willmann-Bell, Inc.
P.O. Box 35025
Richmond, VA 23235
(804) 320-7016
Publisher, Mail Order Dealer

When contacting suppliers — don't forget to mention that you saw their listing in the *ASTRONOMY Equipment Directory*!

COMPUTERS & SOFTWARE

A. A. Star Systems
P.O. Box 1042
Fair Oaks, CA 95628
(916) 782-4061

American Only, Inc.
Scientific & Technical Software Division
13361 Frati Lane
Sebastopol, CA 95472
(707) 874-2352
Retail Dealer

Andromeda Software, Inc.
229 Palmdale Dr.
P.O. Box 1361
Williamsville, NY 14221

AstroSoft, Inc.
P.O. Box 4451
Hayward, CA 94540-4451

Byteland Computers, Inc.
943 N. Expressway, Suite 20
Brownsville, TX 78520
(512) 544-6871
Mail Order Dealer

CompuServe
P.O. Box 20212
Columbus, OH 43220
(614) 457-0802

Computer Assist
1122 13th Street
Golden, CO 80401
(303) 279-2073

Cosmo-Logique
P.O. Box 105
Dorion-Vaudreuil, QUE J7V 5W1 Canada
(514) 455-7703
Manufacturer, Mail Order Dealer
Distributor of Andromeda, the only planetarium software with on-screen movement! Runs on Apple II; soon on IBM PC. Demo version $10.

E&M Software Company
Macintosh™ Software Division
95 Richardson Road
North Chelmsford, MA 01863
(617) 251-7451
Manufacturer

Interstel Corporation
P.O. Box 57825
Webster, TX 77598
Manufacturer, Retail Dealer, Mail Order Dealer

J-ASTRO
20 Argonne Plaza, Box 321
Oakridge, TN 37830
(615) 693-9425
Mail Order Dealer

Libra Systems
Astronomical Software
747 John Carroll Lane
West Melbourne, FL 32904
(305) 729-0522
Manufacturer

Lightspeed Software
2124 Kittredge Street, Suite 185
Berkeley, CA 94704
(415) 486-1165
Manufacturer, Mail Order Dealer
Reviews in numerous astronomy & computer magazines acclaim THE OBSERVATORY as the best sky simulator for the Apple II. Write today for a free brochure.

Micropac
31 Wilmot Rd.
Hamden, CT 06514
(203) 389-5978

Picoscience
41512 Chadbourne
Fremont, CA 94539
(415) 498-1095 (evenings/weekends)

Stellar Software
P.O. Box 10182
1082 Sterling Avenue
Berkeley, CA 94709

Stellatron
122 C. R. 510
Durango, CO 81301

Tachyon Systems
Astroware Products
55 Hillside Road
Sparta, NJ 07871
(201) 729-9508
Manufacturer, Mail Order Dealer

Visionary Software
Astronomical Software
P.O. Box 1063
Midland, MI 48641-1063
(517) 835-9025
Manufacturer, Mail Order Dealer

Zephyr Services
1900 Murray Avenue
Pittsburgh, PA 15217
(412) 422-6600
Manufacturer, Mail Order Dealer

ASTRO-SPECIALTIES

Andco
Halley Comet Video
Drawer 539
Morton, MS 39117
Mail Order Dealer

Arcans Light Productions
Videstar — Starburst
4680 Portola
Santa Cruz, CA 95062
(408) 479-1785
Manufacturer

Astro Audio Company
P.O. Box 543, 139 Main Street
Ivoryton, CT 06442
(203) 767-0525

Chest Works
Astro T-Shirts & Custom Screen Printing
1391 N. 72nd Street
Milwaukee, WI 53213
(414) 476-6986
Mail Order Dealer

Cotton Expressions
Astronomical T-Shirts
832 West Junior Terrace
Chicago, IL 60613
Manufacturer, Mail Order Dealer

Crescent Productions
Backyard Astronomy Videos
P.O. Box 14771
Fremont, CA 94539

Exactly, Inc.
Swiss Moon Watches
110 E. 9th Street, Suite B 1026
Los Angeles, CA 90079

Galactitag
T-shirts & Dog Tags
P.O. Box 262
Sea Girt, NJ 08750
Mail Order Dealer

Gemini
Sidereal Wristwatches
8930 Blue Smoke Drive
Gaithersburg, MD 20879
(301) 921-0157
Mail Order Dealer

Graffiti
"Halley's Comets 2214" T-Shirts
1016 Fairmont Street
Chattanooga, TN 37405
Mail Order Dealer

Halcyon Films and Video
Space Shuttle Videos
110 Beach Rd.
Kings Point, NY 11024
(800) 821-2102
Mail Order Dealer

Hayes & Nolly Productions
Space Videos
300 Alamo Drive, Suite 206
Vacaville, CA 95688
(800) 437-0800 CA-(800) 437-0888

Historical Techonology, Inc.
Antique Scientific Instruments
6 Mugford Street
Marblehead, MA 01945
Publisher, Mail Order Dealer

Imagninova, Inc.
Bayeux Tapestry Kits
P.O. Box 4469
Warren, NJ 07060
(201) 356-2788

JS&A
BluBlockers Sunglasses
One JS&A Plaza
Northbrook, IL 60062
(800) 228-5000
Mail Order Dealer

Meteorite Research & Recovery
10351 N. Shannon
Tucson, AZ 85741
(602) 742-4310
Mail Order Dealer

Meteorites — Robert A. Haag
Box 27527
Tucson, AZ 85726
Mail Order Dealer

Meteorites — Blaine Reed
907 Country Rd., 207 #17
Durango, CO 81301-7728

MMI Space Science Corporation
2950 Wyman Parkway, Box 19907
Baltimore, MD 21211
(310) 366-1222

Mr. Orbit
P.O. Box 592175
Orlando, FL 32859-2175
(305) 857-8375
Mail Order Dealer

Orbic Systems, Inc.
Astronomical Mobiles
109 Eltingville Blvd.
Staten Island, NY 10312
(718) 356-2328

ProSpec Watch Co.
Zodiac watch
P.O. Box 1000
Kings Park, NY 11787
(516) 265-7505 (800) 851-5100
Manufacturer

The Reumund Observatory
Astronomical Photographs
P.O. Box 66
Ballstrom Lake, NY 12019

Ricon Enterprises
Space Shuttle Videos/Products
5863 Village Forest Court
Houston, TX 77092
(713) 683-0105
Manufacturer, Mail Order Dealer

Science & Art Products
Astro-Image T-shirts
P.O. Box 1166
Malibu, CA 90265-1166
(213) 456-2496

St. James' House Company
Antique Scientific Instruments
4142 West Peterson Avenue
Chicago, IL 60646
(312) 545-0011
Manufacturer, Retail Dealer, Mail Order Dealer

Tesseract
Early Scientific Instruments
Box 151
Hastings-on-Hudson
New York, NY 10706

University Microfilms International
Periodicals on Microfilm
300 North Zeeb Road
Ann Arbor, MI 48106

Ursa Major
Night Star Stencil
P.O. Box 3368
Ashland, OR 97520
(503) 482-1322
Manufacturer, Mail Order Dealer

Whirlwind 'T' Shirts
65 Inman Street
Cambridge, MA 02139
(617) 868-0946
Manufacturer, Retail Dealer, Mail Order Dealer

TRAVEL & TOURS

Equapolar Tours
Box 1471
Lawrence, KS 66044
(913) 842-1009

Explorers Travel Club Ltd.
2 York Road
Maidenhead SL6 1SF, England
(011-44) 628-23564

Paradise Safaris
P.O. Box A-D
Kailua Kona, HI 96745

Scientific Expeditions
Division of World of Oz
20 East 49th Street
New York, NY 10017
(212) 826-0855 (800) 248-0234
Total solar eclipse March 18, 1988. 3 minutes plus! 16 day cruise aboard Golden Odyssey-prices from $2078 plus airfare-send for free brochure.

Starship Travel
4072 Nescouset Highway
E. Setauket, NY 11733
(516) 331-3303

Sun Line Cruises
One Rockefeller Plaza, Ste. 315
New York, NY 10020
(212) 397-6400

Travel Bug International
P.O. Box 178247
San Diego, CA 92117
(619) 268-8687

Twilight Tours
3316 W. Chandler Boulevard
Burbank, CA 91505
(818) 841-8245

EQUIPMENT DEALERS

ALABAMA

Van's Photo, Inc.
P.O. Box 2585, Mobile, AL 36652
(205) 479-6575

ALASKA

Carr's Quality Centers, Inc.
1341 Fairbanks St., Anchorage, AK 99501
(907) 277-6639

ARIZONA

Guild Camera Shop, Inc.
737 West Camelback Rd., Phoenix, AZ 85013
(602) 264-5808

Nuart Photo Service
P.O. Box 5505, Tucson, AZ 85703
(602) 326-9606

Spectrum
P.O. Box 32188, Phoenix, AZ 85016
(602) 955-6773

Wilson Camera Sales, Inc.
3144 East Camelback Rd., Phoenix, AZ 85016
(602) 955-6773

ARKANSAS

Camera Mart, Inc.
10014 Rodney Parham, Little Rock, AR 72207
(501) 227-7202

CALIFORNIA

Boots Camera Corp.
5587 N. Blackstone, Fresno, CA 93710
(209) 432-0446

California Telescope Company
P.O. Box 1338, Burbank, CA 91507
(818) 505-8424

Camera Mart
P.O. Box 16720, San Diego, CA 92116
(619) 235-6564

Canoga Cameras
22065 Sherman Way, Canoga Park, CA 91303
(818) 346-5506

Celestial Systems
2428 Jefferson St., Napa, CA 94558
(707) 224-3195

Century Telescope Center
12553 Harbor Blvd., Garden Grove, CA 92640
(714) 530-3861

Desert Sky Optical
45104 Trevor Ave., #121, Lancaster, CA
93534
(805) 945-1171

Earl Watts Optics
26638 Jamaica Lane, Hayward, CA 94545
(415) 786-2967

Fireside Camera
217 Chestnut St., San Francisco, CA 94123
(415) 567-8191

Gluskins Cameras Audio Video
2110 Pacific Ave., Stockton, CA 95204
(209) 466-5686

Jaffe's Camera Center
2640 East Main, Ventura, CA 93003
(805) 643-2231

King Photo Supply
747 W. Lancaster Blvd., Lancaster, CA 93534
(805) 948-8441

Los Angeles Optical Company
12129 Magnolia Blvd.,
N. Hollywood, CA 91607
(818) 762-2206

McCurry Companies, Inc.
P.O. Box 838, Sacramento, CA 95804
(916) 444-6080

Nelson Photo Supplies
P.O. Box 85127, San Diego, CA 92138
(619) 234-6761

Oceanside Photo & Telescope
207 North Hill St., Oceanside, CA 92054
(619) 722-3348

Oceanview Instruments
2523 West Pacific Coast Hwy., Newport
Beach, CA 92663
(714) 646-3275

Optica b/c Company
Astronomy Division
4100 MacArthur Blvd., Oakland, CA 94619
(415) 530-1234

Orion Telescope Center
421 Soquel Avenue, Santa Cruz, CA 95062
(800) 447-1001

Paul's Photo Inc.
23252 S. Hawthorne, Torrance, CA 90505
(213) 375-7014

Ronald N. May
Woodland Hills, CA 91364
(818) 883-0140

Roseville Hardware
203 Harding Blvd., Roseville, CA 95678
(916) 782-8402

Scope City
679 Easy St., Simi Valley, CA 93065
(805) 522-6646

Silvio's Photo Center
2597 Pacific Coast Hwy., Torrance, CA 90505
(213) 539-3400

Sky Optical
12428 Gladstone St., Sylmar, CA 91342
(818) 361-6576

Star Magic
4026 24th St., San Francisco, CA 94114
(415) 641-8626

Star Quest Enterprise
378 S. Tustin Ave., Orange, CA 92666
(714) 633-8505

The Nature Center
11743 Fair Oaks Blvd., Fair Oaks, CA 95628
(916) 967-5781

The Telescope Exchange
4347 Sepulveda Blvd., Culver City, CA 90230
(213) 397-0871

Tony Rose Camera
5666 Calle Real, Goleta, CA 93117
(805) 967-5621

Wentling Camera & Video
1673 Willow Pass Rd., Concord, CA 94520
(415) 685-2234

COLORADO

Godec's Photo Supply
9 South Weber, Colorado Springs, CO 80903
(303) 634-8833

Robert Waxman, Inc.
913-15th St., Denver, CO 80202
(303) 623-1155

S & S Optika, Ltd.
5172 S. Broadway, Englewood, CO 80110
(303) 789-1089

CONNECTICUT

Camera 1
150 Eugene O'Neill Dr.,
New London, CT 06320
(203) 443-8973

Camera Shop of New Britain
P.O. Box 1900, New Britain, CT 06050
(203) 229-2057

Milford Camera Shop, Inc.
9 River St., Milford, CT 06460
(203) 878-0156

New England Astro-Optics, Inc.
P.O. Box 834, Simsbury, CT 06070
(203) 658-0701

Pauli's Discount Optics
29 Kingswood Rd., Danbury, CT 06811
(203) 746-3579

FLORIDA

Colonial Photo & Hobby Inc.
634 North Mills Ave., Orlando, FL 32803
(305) 841-1485

Cost Plus Camera
1031 E. Hwy. 434, Winter Springs, FL 32708
(305) 695-0270

Harmon Photo & Video
14330 S. Tamiami Tr., Fort Myers, FL 33912
(813) 482-6661

Kenin, Inc.
1830 N.E. 163rd St., N. Miami Beach, FL
33162
(305) 949-7681

Sunwest Space Systems, Inc.
5545 9th St. N., St. Petersburg, FL 33703
(813) 527-6270

Tallahassee Camera Center, Inc.
2880 Apalachee Pkwy.,
Tallahassee, FL 32301
(904) 877-1152

The Great National Camera Machine, Inc.
Lantana Shopping Center, Lantana, FL 33462
(305) 689-3155

GEORGIA

Camera America
1706 Gornto Rd., Valdosta, GA 31602
(912) 247-7252

Cheshire Optical Instrument Company
Box 65, Mableton, GA 30059
(404) 944-9200

Wolf Camera, Inc.
150-14th St., N.W., Atlanta, GA 30318
(404) 892-1707

HAWAII

Rainbow Camera Inc.
802 Fort Street Mall, Honolulu, HI 96813
(808) 531-4618

ILLINOIS

American Science Center
601 Linden Pl., Evanston, IL 60202
(312) 475-8440

Cosmic Connections, Inc.
1460 North Farnsworth Ave., Aurora, IL 60505
(312) 851-5353

Lion Photo/Schamburg
500 Golf Rd., Schamburg, IL 60195
(312) 882-6210

Shutan Camera & Video
312 West Randolph, Chicago, IL 60606
(800) 621-2248

Vogel Enterprises, Inc.
P.O. Box 3717, Oak Park, IL 60303
(312) 456-8725

INDIANA

Camera Hut
3834 Georgetown Rd., Indianapolis, IN 46254
(317) 297-1498

Jorgensen's, Inc.
6226 Covington Rd., Fort Wayne, IN 46804
(219) 432-5519

KANSAS

Wolfe's Camera & Video
635 Kansas Ave., Topeka, KS 66603
(913) 235-1386

KENTUCKY

Schuhmann's Click Clinic
425 West Chestnut St., Louisville, KY 40202
(502) 584-2145

LOUISIANA

Ep Roberts Instruments, Inc.
3213 17th St., Metairie, LA 70002
(504) 834-4078

MARYLAND

Ritz Camera Centers, Inc.
6711 Ritz Way, Beltsville, MD 20705
(301) 953-9611

Towson Photo Supply
401 Washington Ave., Towson, MD 21204
(301) 296-1717

MASSACHUSETTS

F.C. Meichsner Co.
182 Lincoln St., Boston, MA 02111
(617) 426-7092

Lechmere
P.O. Box 2059, Woburn, MA 01888
(617) 935-8320

Underground Camera, Inc.
369 Central St., Foxboro, MA 02035
(617) 543-9351

MICHIGAN

Adray Photo & Appliance
20219 Carlysle, Dearborn, MI 48124
(313) 274-9500

Camera Center Inc.
1533 Wealthy St., S.E.,
Grand Rapids, MI 49506
(616) 458-7703

Rider's Hobby of Flint
3012 Corunna Rd., Flint, MI 48503
(313) 234-4051

Rider's Hobby of Lansing
1609 East Michigan, Lansing, MI 48912
(517) 485-0700

University Optics Inc.
P.O. Box 1205, Ann Arbor, MI 48106
(800) 521-2828

MINNESOTA

Black's Photography
1201 West Broadway, Minneapolis, MN 55411
(612) 629-9581

National Camera Exchange
9300 Olson Hwy., Golden Valley, MN 55427
(800) 328-4815

Northern Sky Telescopes, Inc.
5667 Duluth St., Golden Valley, MN 55422
(612) 545-6786

MISSISSIPPI

Deville Camera, Inc.
P.O. Box 12371, Jackson, MS 39211
(601) 956-9283

MISSOURI

Columbia Photo & Video
310 N. 10th St., Columbia, MO 65205
(314) 443-0503

Creve Coeur Camera, Inc.
700 N. New Ballas Rd.,
Creve Coeur, MO 63141
(314) 567-3456

Lawrence Photo-Graphic
1310 Carondelet, Kansas City, MO 64114
(816) 941-3200

MONTANA

Classic Cutlery & Optics
Rimrock Mall, Billings, MT 59102
(406) 652-6954

NEBRASKA

Rockbrook Camera Center
11032 Elm St., Omaha, NE 68144
(402) 397-1171

NEW JERSEY

Bergen County Camera
270 Westwood Ave., Westwood, NJ 07675
(201) 664-4411

Camera Discount Center
777 Route 17 North, Paramus, NJ 07652
(800) 631-7111

Corral Camera
900 Tilton Rd., Northfield, NJ 08225
(609) 641-5515

Dover Photo Supply, Inc.
25 East Blackwell St., Dover, NJ 07801
(201) 366-0994

Edelman's
465 Route 46 West, Wayne, NJ 07470
(201) 227-2515

Fishkin Bros., Inc.
285 Madison Ave., Perth Amboy, NJ 08861
(201) 826-0048

Photo Cullen
574 Valley Rd., Upper Montclair, NJ 07043
(201) 746-1234

Roger Tuthill, Inc.
11 Tanglewood Ln., Mountainside, NJ 07092
(800) 223-1063

The Photo Center
Laurel Square Shopping Center,
1930 Route 88, Bricktown, NJ 08724
(201) 840-1333

NEW MEXICO

Photo Supply
DeVargas Mall, Santa Fe, NM 87501
(505) 982-2585

NEW YORK

47th Street Photo
36 East 19th St., New York, NY 10003
(800) 221-7774

Adorama Camera Inc.
138 West 34th St., New York, NY 10001
(800) 223-2500

Advance Camera Corp.
15 West 46th St., New York, NY 10036
(212) 944-1410

Arax Photo Supply Co., Inc.
388 Main Mall, Poughkeepsie, NY 12601
(914) 298-9552

B&C Photo Supply
317 North Water St., Elmira, NY 14901
(607) 732-3543

Berger Bros. Camera Exchange
209 Broadway, Amityville, NY 11701
(516) 264-4160

Berns' Camera Stores
84-86 North Pearl, Albany, NY 12207
(518) 463-7777

Blumenthal's Inc.
234 North Union St., Olean, NY 14760
(716) 372-4008

Camera Concepts
39 East Main St., Patchogue, NY 11772
(516) 475-1118

Cameras 'N Things
210 The Commons, Ithaca, NY 14850
(607) 277-4360

Colortone, Inc.
76 South Central Ave., Elmsford, NY 10523
(914) 949-7884

Combine Camera Stores
225 Hempstead Trpk., W. Hempstead,
NY 11552
(516) 481-4500

Dave's Photo Shop
Pyramid Mall, Johnstown, NY 12095
(518) 762-3780

Delaware Camera Mart, Inc.
2635 Delaware Ave., Buffalo, NY 14216
(716) 877-3317

Discovery Shoppes
1060 Niagara Falls Blvd., Buffalo, NY 14150
(716) 836-1690

Edwin Hirsch
168 Lakeview Dr., Tomkins Cove, NY 10986
(914) 786-3738

Executive Photo & Supply Corp.
120 West 31st St., New York, NY 10001
(800) 223-7323

Focus Camera Inc.
4419-21 13th Ave., Brooklyn, NY 11219
(800) 221-0828

Foto Cell
49-51 W. 23rd St., New York, NY 10010
(212) 924-7474

Ithaca Photo
110 West Green St., Ithaca, NY 14850
(607) 273-0353

Jena Scientific Instruments, Inc.
820 Second Ave., New York, NY 10017
(212) 867-3051

Johnson's Studio & Camera
3208 Erie Blvd., Syracuse, NY 13214
(315) 446-0290

Ken-Mar Camera
27 Great Neck Rd., Great Neck, NY 11021
(516) 482-1025

Lindsay Photo Service
Rainbow Center, Niagara Falls, NY 14302
(716) 285-8861

Main Camera Center
16 Franklin Ct., Rochester, NY 14604
(716) 232-4890

The Camera Company
320 Wheatley Plaza, Greenvale, NY 11548
(516) 621-0102

Photo Factory
99 East Market St., Corning, NY 14830
(607) 962-3785

R.V.R. Optical
P.O. Box 62, Eastchester, NY 10709
(914) 337-4085

Ray Supply, Inc.
Upper Glen St., Glens Falls, NY 12801

Severance Photo
170 Court St., Watertown, NY 13601
(315) 788-3870

Sporting Optics, Inc.
P.O. Box 5, Amsterdam, NY 12010
(518) 842-0863

Sports Town
279 Main St., Huntington, NY 11743
(516) 427-2564

Stangert Corporation
94 Long Beach Rd., Island Park, NY 11558
(516) 432-4277

Star Magic
275 Amsterdam Ave., New York, NY 10023
(212) 769-2020

Star Magic Industries Inc.
743 Broadway, New York City, NY 10003
(212) 228-7770

TBR Associates Inc.
850 Hudson Ave., Rochester, NY 14617
(716) 544-2162

The Camera Center
51 Washington Ave., Endicott, NY 13760
(607) 748-4083

Wall Street Camera Exchange
82 Wall St., New York, NY 10005
(800) 221-4090

OHIO

Don McAlister Co., Inc.
1454 West Lane Ave., Columbus, OH 43221
(614) 488-1865

Eastern Hills Camera
7819 Montgomery Rd.,
Cincinnati, OH 45236
(513) 791-2140

Fairborn Camera, Inc.
14 East Main St., Fairborn, OH 45324
(513) 878-4392

Optics Ohio, Inc.
P.O. Box 1439, Lancaster, OH 43130
(312) 851-5353

OKLAHOMA

Ad-Libs Astronomics
2401 Tee Circle, Norman, OK 73069
(405) 364-0858

Astro-Tech
101 W. Main, Ardmore, OK 73402
(405) 226-3074

Camera Gallery, Inc.
8172 East 68th St., Tulsa, OK 74133
(918) 252-3652

OREGON

Dot Dotson's
P.O. Box 10606, Eugene, OR 97440
(503) 485-1773

PENNSYLVANIA

Van Tuil Discount Photo and Video
2254 East 8th St., Erie, PA 16505
(814) 453-6601

SOUTH CAROLINA

Jackson Industries
P.O. Box 9098, Columbia, SC 29290
(803) 776-7000

TENNESSEE

American Camera
5251 Poplar Ave., Memphis, TN 38119
(901) 683-2200

TEXAS

Astronomy Place
2536 N. Beltline Rd., Dallas, TX 75062
(214) 256-0505

Bill Weaver Sporting Goods
3515 Wet Vickery, Fort Worth, TX 76107
(817) 731-0804

Crown Hobby & Toy
6721 Preston Rd., Dallas, TX 75205
(214) 528-3880

Doc Miller Cameras
6959 Araphaho Rd., #513, Dallas, TX 75248
(214) 385-3923

H.G.F. Scientific, Inc.
2829 North Main, Stafford, TX 77477
(713) 499-3000

Southwestern Camera
P.O. Box 70699, Houston, TX 77270
(713) 880-2505

Texas Nautical Repair Co.
2129 Westheimer, Houston, TX 77098
(713) 529-3551

UTAH

Camera Den, Inc.
145 South State St., Salt Lake City, UT 84111
(801) 322-3915

Hammond Hobby
Cottonweed Mall, Salt Lake City, UT 84117
(801) 278-0156

VIRGINIA

Ewald-Clark, Inc.
213 Draper Rd., Blacksburg, VA 24061
(703) 552-9300

New Energy Sciences, Inc.
Fair Oaks Mall — 11703L, Fairfax, VA 22033
(703) 385-5773

Redlich Binocular & Optical Repair Service
2319 Wilson Blvd., Arlington, VA 22201
(703) 527-5151

WASHINGTON

Aries Optics Inc.
Route 1, Box 143 G, Palouse, WA 99161
(509) 878-1713

Dick's Camera & Video
15421 1st Avenue South, Seattle, WA 98148
(206) 244-1101

Olympic Camera Center
1319-4th Ave., Seattle, WA 98101
(206) 623-1070

The Camera Shop
1003 Pacific Ave., Tacoma, WA 98402
(206) 627-4159

WEST VIRGINIA

Merrill Photo Supply Co. Inc.
233 Hale St., Charleston, WV 25301
(304) 343-0141

WISCONSIN

American Discount Optics
2404 West Beltline Hwy., Madison, WI 53713
(608) 271-1000

CANADA — ALBERTA

Quasar Optics Inc.
7220A Fairmount Dr. S.E.,
Calgary, ALB T2H 0X7
(403) 255-7633

CANADA — ONTARIO

Cosman & Associates
P.O. Box 100, Station A,
Islington, ONT M9A 4X1
(416) 239-9591

Perceptor
1048 1/2 Kingston Rd., Toronto, ONT M4E 1T4
(416) 694-8273

Scope City
247 Marlee Ave., Toronto, ONT M6B 4B8
(416) 783-4140

The Scope Shop
5230 Dundas St. West, Six Points Plaza,
Islington, ONT M9B 1A8
(416) 232-1609